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of Transportation

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Administration

Advisory Circular

Subject: GUIDE SPECIFICATION FOR WATER/FOAM
AIRCRAFT. RESCUE AND FIREFIGHTING VEHICLES

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Change:

1. **PURPOSE.** This advisory circular (AC) contains performance **Standards**, specifications, and recommendations for the design construction, and testing of a family of aircraft **rescue** and firefighting (ARFF) vehicles.

2. **CANCELLATION.** AC 150/5220-10A, Guide Specification for Water/Foam **Aircraft** Rescue and **Firefighting** Vehicles, dated July 3, 1991, is canceled.

3. **APPLICATION.** The Federal Aviation Administration **recommends** the use of the guidance in

this publication for the preparation of ARFF vehicle specifications. For airport projects receiving Federal grant-in-aid assistance, the use of these standards is **mandatory**. At certificated airports, the use of equipment meeting these standards is an acceptable means of satisfying the requirements of Federal Aviation Regulations (FAR), Part 139, Subpart D-Operations, Subparagraph 139.317, Aircraft rescue and firefighting: Equipment and agents.

DAVID L. BENNETT
Director, **Office** of **Airport Safety** and Standards



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CHAPTER 1. INTRODUCTION.

Section 1. General Characteristics.

1. DEFINITIONS. Terms with meanings unique or specifically related to aircraft rescue and firefighting (ARFF) vehicle design, construction, and performance requirements are contained in Appendix 1.

2. EXPECTED USE. This guide specification covers four classes of all-wheel drive, diesel-powered ARFF vehicles having a mechanical foam/water system designed for extinguishing flammable and combustible liquid fuel fires. The dry chemical and Halotron I or approved equivalent complimentary agent systems described in chapter 3 are acceptable, optional additions to the basic vehicle when dictated by local operational needs. However, the primary function of the vehicles described in this guide specification is to provide an optimum level of ARFF suppression capability throughout the critical rescue and firefighting access area for the lowest practical cost.

These vehicles may also be suitable for other fire protection assignments at the airport. Vehicles complying with this basic specification meet the ARFF vehicle requirements of 14 Code of Federal Regulations (CFR) Part 139.

3. FIRE SUPPRESSION CHARACTERISTICS. These vehicles are designed for a degree of off-pavement mobility not normally found in highway vehicles. The vehicle payload consists principally of the minimum usable (rated capacity) quantities of water shown in Table 1 and sufficient foam concentrate to mix at the appropriate concentration with twice that water quantity.

4. RESERVED.

Table 1. Minimum Usable Water (Rated Capacity) .

Class	Gallons - (US)	Liters
1	1,000	3 785
2	1,500	5 678
3	2,500	9 463
4	3,000 and over	11 355 and over

Section 2. Ergonomics.

5. CREW SPACE.

a. All crew **space** shall be restricted to the interior of a fully enclosed cab. The maximum crew capacity of the cab (seated positions with approved, **3-point** restraints as minimum seat belts or shoulder harness system) shall be clearly posted on a label in the cab.

b. Where practicable, instruments shall be used in preference to warning lights. A means to readily test the condition of all warning light bulbs shall be provided.

c. Instruments and warning lights shall be displayed so that they will be useful, convenient, and visible to the driver.

d. The instrument panel(s) shall either be easily removable as units or hinged for back access. Quick disconnect fittings shall be used for all electrical connections to the instrument panel. All instruments, except liquid filled gauges, shall be illuminated by red lighting. Labels for control and instruments should be backlit or illuminated.

e. Provisions shall be made to mount the radio(s) and the associated controls such that they shall be

operable by the driver and at least one other crew member without leaving the cab or removing their seat belts. The mounting provisions shall take into consideration the fact that radio operating equipment **may** include boom/microphone headsets with appropriate controls, radio interconnects, and remote or foot-operated push-to-talk switches, as specified by the purchaser. If a vehicle is to be equipped with headsets, appropriate storage boxes shall be provided to protect this equipment.

f. All rotating or reciprocating parts, all parts with operating temperatures above 120° F (49° C), or which are electrically energized, or are of such a nature or so located as to be a hazard to the safety of operating and maintenance personnel during their normal duties, shall be insulated, enclosed, or guarded as appropriate for the specific hazard and its location.

g. A.11 space which is occupied or **from** which work is performed during operations, servicing, and maintenance of the vehicles, shall be free **from** hazardous protrusions, sharp edges, cracks, or other elements which might reasonably be expected to cause injury to personnel.

6. RIDE QUALITY..

a. The design objective for the vehicle ride quality shall be to permit safe operation over rough roads and adverse terrain found at the airport of intended service at speeds up to at least 15 mph (24 km/h) without causing injury to the operating personnel (wearing seat belts) or damage to the vehicle.

b. The design objective for all vehicle and fire extinguishing system controls shall be to permit driving and firefighting operations which do not require effort by operating personnel in excess of the limits specified in the current version of **MIL-STD-1472**, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

7. CONTROLS.

a. All the controls necessary for the full operation of the vehicle and for activating the **firefighting** system shall be within reach of the driver. Controls for the fire extinguishing system(s) shall also be within easy reach of a second crew station or duplicated for that crew station.

b. Firefighting equipment and controls located on the vehicle exterior shall be placed between 24 inches (61 cm) and 66 inches (168 cm) above the ground, catwalks, or deck plates, as applicable.

c. All controls shall be labeled with a permanent label identifying function and/or limitation.

8. SAFETY FEATURES.

a. A warning siren/device shall be provided, and it shall:

(1) be a multi-tone, multi-volume **state-of-the-art** device used as a common industry practice- on emergency vehicles.

(2) produce a minimum sound of 95 decibels at 100 feet (30 m) directly in **front** of the vehicle; and 90 decibels at 100 feet (30 m) and 45 degrees left and right of front center.

(3) be mounted so as to be protected from drippings **from** the turret and water splashed up by the tires. The control(s) shall be accessible to both the driver and a second crew member.

b. A horn shall be provided and mounted so as to achieve optimum sound projection to the **front** of the vehicle. A control button or horn ring shall be located at the steering wheel.

c. A "vehicle backing" warning device, audible up to 25 feet (7.6 m) behind the vehicle, shall be provided. Shifting the transmission into reverse shall activate this device.

Section 3. Design Criteria.

9. PERFORMANCE. The design objective for the vehicle and the tire extinguishing system shall be performance in accordance with Section 7, Chapter 2.

Performance for the tire extinguishing system shall be in accordance with Section 7, Chapter 3. Manufacturers shall be required to identify their loaded

apparatus' center of gravity as well as the safe operating envelop of the loaded vehicle to include side slope maneuverability and high speed cornering.

10. FLEXIBILITY. The design objective for the vehicle frame, suspension, and mounting of major components shall be to provide the capability for diagonally opposite **wheel** motion up to 14 inches (36 cm) above ground without raising the remaining wheels from the ground or causing interference or parts failure.

11. MAINTAINABILITY. The vehicle design shall be such that it:

a. Uses the fewest number of different parts consistent with the specified performance.

b. Permits maintenance with commercially available, general purpose mechanic tools and equipment (metric sizes are permitted if required tools are "standard" and "commercially available"). The vehicle manufacturer shall identify and document in the maintenance manual introduction any special or nonstandard tools required and any unique test equipment required to perform operator/owner maintenance and service.

c. Limits the number of tools and the variety of spare parts required for maintenance by such design practices as reducing the variety of bolt sizes, light bulb sizes, wire gages, tubing and pipe sizes consistent with safety and performance requirements.

d. Uses disconnect plugs, receptacles, junction boxes, bus bars, multiple-line connectors in the electrical systems, and readily detachable fittings in hydraulic and pneumatic systems, as applicable. All disconnect points shall be clearly labeled. All hydraulic and pneumatic lines and electrical wires shall be color- or number-coded.

e. Includes pilots, guides, slides, carriages, or other features where such provisions can add to the ease of removal and installation or attachment of components.

f. Uses a fastener system that is easily disassembled and reassembled for all cabinets and body-work that must be removed for access for maintenance and removal of components for repair or replacement.

g. Operates with standard commercial lubricants. Grease and oil seals shall be of a design and located to provide accessibility for inspection, servicing, and replacement. Panels which must be opened for access to lubrication points shall be hinged. Lubrication fittings shall be located in accessible, protected positions. Parts or assemblies which are not readily accessible for direct lubrication, or are likely to be overlooked because of inaccessibility, shall have extended fittings. A safety chain shall attach filler caps to lubrication fill points where practical.

h. Locates drains, tiller plugs, grease fittings, hydraulic line-bleeders, and checkpoints so that they are readily accessible and do not require special tools for proper servicing.

i. Ensures that the installation of each major subsystem or critical part can only be in its proper operating position.

j. Provides accessible connections,- where needed, to attach troubleshooting, analytical, and diagnostic equipment to appropriate vehicle subsystems.

k. Includes the installation of continuous duty cycle lubrication systems for suspension lubrication points and other mechanical equipment joints to increase the duty cycle of components and extend the useful life of the vehicle.

12. COMPONENT PROTECTION.

a. All oil, hydraulic, air, water, foam concentrate, and electrical system conduits, tubing and hoses shall be located in protected positions. They shall be secured to the frame or body structure and, except where a through-frame connector is necessary, shall be fitted with protective looms or grommets at each point where they pass through panels or structural members.

b. All radiator grills, louvers, lamps, tie rods, drive shafts, piping, and other vulnerable components shall be protected by component location or by guards adequate to prevent damage **from** brush, stones, logs, etc., likely to be encountered by the vehicle during off-road performance.

13. PAINTING, MARKING, AND LIGHTING.

a. Vehicles shall be painted and marked to comply with the painting, marking and lighting standards of AC 150/5210-5B, Painting, Marking, and Lighting of Vehicles Used on an Airport.

b. Lighting equipment shall be provided as specified in paragraph 39.

14. INSULATION, WATERPROOFING, AIR CONDITIONING, AND WINTERIZATION.

a. Insulation shall be fire and water resistant and of a type that will not pack or settle. Provision shall be made to allow the drainage of water from between the walls by gravity flow. The average heat loss shall not exceed 0.24 BTU/ft² (0.76 W/m²) per degree Fahrenheit per hour. All insulation which could be exposed to abrasion or damage from equipment storage or operator activities shall be provided with a protective covering. All insulation which will be located on the exterior of the vehicle shall be protected from damage of exposure by a permanent cover to be constructed and painted to match the vehicle exterior (metal or fiber glass).

b. All components shall be designed, installed and/or protected so that their normal function will not be impaired by heavy rains, road splash, formation of condensation, or the spillage of extinguishing agents from nozzles and fittings, recharging operations, or leaks in the piping system.

c. The normal temperature design criteria shall be for vehicle use in a temperature range of 32° F (0° C) to 115° F (43.5° C).

d. If, in the judgment of the purchaser, the operational practices of the ARFF service at a specific airport warrant the use of air conditioning, a system that meets current automotive/truck and environmental protection standards for vehicle air conditioning may be specified by the purchaser. The use of the air conditioning shall not change the acceptable pass/fail criteria for any of the performance tests of the vehicle or the firefighting system by more than ± 5 percent

when tested in ambient temperatures up to 115° F (43.5° C).

e. If, in the judgment of the purchaser, the climatic conditions combined with the normal operational procedures at a specific airport warrant the use of special freeze protection, a winterization system that meets the requirements of paragraph 50 may be specified by the purchaser.

15. MATERIALS.

a. Materials not specifically covered by this specification or applicable referenced specifications or standards shall be of the best quality currently used in commercial practice for ARFF vehicle fabrication.

b. Dissimilar metals shall not be in contact with each other. Metal plating or metal spraying of dissimilar base metals to provide electromotively compatible abutting surfaces is acceptable. The use of dissimilar metals separated by suitable insulating material is permitted, except in systems where bridging of insulation materials by an electrically conductive fluid can occur.

c. Materials that deteriorate when exposed to sunlight, weather, or operational conditions normally encountered during service shall not be used or shall have a means of protection against such deterioration that will not prevent compliance with performance requirements.

d. Protective coatings that chip, crack, or scale with age or extremes of climatic conditions or on exposure to heat shall not be used.

e. The use of proven, nonmetallic materials in lieu of metal is permitted if that use contributes to reduced weight, lower cost, or less maintenance and there is no degradation in performance or increase in long-term operations and maintenance costs.

16. THROUGH 19. RESERVED.

CHAPTER 2. AUTOMOTIVE SYSTEM.

Section 1. Frame.

20. BALANCE AND CLEARANCES.

a. The weight shall be distributed as **equally** as practical over the axles and tires of the **fully** laden vehicle.

(1) The difference in tire load between **tires** on any axle shall not exceed 5 percent of the average tire load for that axle.

(2) The difference in load between axles shall not exceed 10 percent of the load on the heaviest axle.

(3) The front axle shall not be **the** heaviest axle.

EXCEPTION: The front axle may be the heaviest loaded axle in those cases where **options** specified by the purchaser cannot be practically engineered to conform with this requirement. However, if the front axle is the heaviest, the weight difference between it and any other axle shall not exceed 5 percent. In addition, none of the component ratings shall be exceeded to accommodate this deviation in the balance/weight distribution AND all other performance requirements of this specification shall be met.

(4) Under no circumstances shall axle and tire manufacturer's ratings be exceeded in an **effort** to comply with any of the above.

b. The fully loaded vehicle shall be able to meet the side slope stability standards of Table 2, Performance Parameter 2, applicable to its class.

c. See Table 2, Performance Parameters 4 through 8, for standard clearances.

21. DIMENSIONS.

a. The overall height, length, and width of the vehicle shall be the smallest dimensions consistent with the rated payload for its class and the operational performance requirements of the vehicle.

b. Although payload and operational performance are of primary importance, **cost-effectiveness** and local **functional** consideration, e.g., existing door, bridge, and tunnel clearances, may dictate that one or more specific dimensional requirements be specified by the purchaser.

22. LOAD RATING.

a. The **functional** load rating of the frame shall equal or exceed the actual gross vehicle weight (**GVW**). The GVW includes complete chassis; cab with attachments, accessories, and equipment; the body with rated agent payload, including a full complement of **fuel**, lubricant, coolant, firefighter protective clothing, equipment, and breathing apparatus in appropriate numbers; firefighting hand tools and appliances.

b. The **frame** shall not be altered during installation of the **fire** protection package in any way which will **reduce** its load rating.

Section 2. Body Components.

23. COACH WORK. Parts shall be fabricated **from** materials that will provide the lightest weight consistent with the needs for strength, as well as heat and corrosion resistance. Self-tapping bolts shall not be used in construction of the apparatus body. Safety of the crew shall be a primary consideration in coach work, especially the protection of occupants during a roll over.

24. COMPARTMENTS. The compartments shall be of weather-tight construction and equipped with

closures. Closures shall have positive holding mechanisms in both open and closed positions and may be of track/roll or hinge/swing type. All compartments shall:

a. Be provided with weather proof lights which are switched to automatically light when compartment doors are opened.

b. Have minimum of two (2) vents with a total of 10 squares inches of ventilation. The ventilation shall not be to the outside of the vehicle.

c. Have a drain to allow collected water to run out under the vehicle.

d. Be equipped with a sensor, switch, or device that would send a signal to an indicator in the cab that a compartment door is open.

25. **HANDRAILS.** Handrails or a guardrail shall be provided for personnel safety at all steps, walkways, and elevated work stations: including along the vehicle tank top or tank top till area. The rail material shall be heat and corrosion-resistant or provided with a low maintenance, durable, sunlight, weather, heat, and corrosion-resistant finish. Handrails finish should be of a design that is slip resistant.

26. RUNNING BOARDS, STEPS, WALKWAYS, AND TOWING DEVICES.

a. Running boards, step surfaces, ladder rungs, walkways, and catwalks shall have antiskid treads, deck plates, handrails, and guards as applicable.

(1) The height between steps shall be less than 20 inches (50 cm).

(2) The lower steps shall be less than 24 inches (60 cm) **from** the ground. The lowermost steps may extend below the angle of approach or departure or ground clearance limits if they are designed to swing clear.

(3) The tread of the bottom steps shall be at least 8 inches (20 cm) in width and succeeding steps at least 16 inches (40 cm) in width.

(4) The full width of all steps shall have at least 6 inches (15 cm) of unobstructed toe room or depth when measured **from** and perpendicular to the front edge of the weight-bearing surface of the step.

b. Catwalks and deck plates which provide access to equipment mounted on the vehicle shall withstand the loads imposed by personnel while performing normal service and operational functions.

c. Two towing hooks/eyes with shackles shall be attached directly to the **frame** rails at the front and rear of the vehicle. If requested by the purchaser as an alternate to the rear towing hooks, a **pintle** hook may be attached to the rear **frame** cross member of the vehicle if its presence will not interfere with other components necessary for the required performance. The towing devices may be allowed to intrude into **the** 30 degree approach angle in order to provide ease of connection if needed.

Section 3. Cab and Accessories.

27. **CONTROLS.** Unless otherwise noted, the following cab mounted controls shall be provided as applicable for the safe and efficient operation of the vehicle:

Accelerator Pedal.
 Agent Flow Control.
 Air Conditioner Controls, if specified.
 Brake Pedal.
 Complimentary Agent/System Activation.
 Differential Lock Control.
 Dimmer Control.
 Dome Light Switch Manual/Door Activated, with white/red light selector switch if specified.
 Engine Shutdown Switch.
 Flashing Beacon **Switch(es)**.
 Foam Concentrate Reservoir Control Valve.
 Headlight Switch.

Heater/Defroster Controls.
 Horn Control.
 Ignition Switch.
 Master Electrical Disconnect Switch.
 Panel Lights Switch with Dimmer.
 Parking Brake Control.
 Siren Switch with Microphone.
 Spotlight **Switch(es)**, if specified.
 Starter Switch.
 Steering Wheel, with Self-Canceling Direction Signal
 Top Deck Light Switches, if specified.
 Transmission Range Selector.
 Turret Control.
 Water Flow Control Valve.
 Windshield Deluge System Control, if requested.
 Windshield Wiper and Washer Controls.

28. CREW SPACE AND DOORS.

a. The cab shall:

(1) Have seats for a driver and at least one additional crew member.

NOTE: If additional crew positions are a local operational requirement and are specified by the purchaser, they shall be provided.

(2) Have space for the instruments, radios, controls, and the safety equipment required by the number of firefighters intended to occupy the cab, without hindering crew operations.

(3) Have door(s) which open to at least a 90 degree angle to the cab side on each side of the cab and that shall be **fitted** with appropriate steps and hand grabs. The location of vehicle components or mounted **firefighting** equipment shall not obstruct the cab entrances/exits.

(4) Be constructed and/or so mounted on the vehicle frame so to meet the provisions of paragraph 10.

(5) Be constructed to prevent cab collapse in the event of a vehicle rollover.

(6) Be weather tight and fully insulated in accordance with the provisions of paragraph 14.

b. The cab roof shall have gutters of sufficient size to prevent foam and water **from** dripping on the windshield and side windows during turret operation. All cab' fresh air vents/intakes shall be baffled and drained in such a way that wind-driven rain water and/or water-foam solution sprayed on the vehicle cannot flow into the crew compartment through the air intakes.

c. All glass shall be a laminated or tempered, tinted safety type to meet applicable Federal standards and shall be **free** of imperfections which affect visibility.

d. The design and arrangement of the cab and components shall optimize visibility for a seated driver having an eye height of 3 1 3/4 inches (80 cm).

(1) The lateral field of vision shall be at least 90 degrees left and right of center.

(2) The ground must be visible to the driver at a point at least 15 feet (4.5 m) and beyond from the vehicle through the left two-thirds of the included angle of vision and 30 feet (9 m) **from** the vehicle through the right third of the included angle.

EXCEPTION: Proportional modification of the horizontal visibility range is acceptable for other than a left-mounted driver seat.

(3) The angle of visibility above the horizontal for the seated driver looking through the front cab windows shall be at least 5 degrees. For vehicles equipped with high-reach, extendible turrets, the angle of visibility above the horizon shall extend to a point 30 feet (9m) above ground level at a distance of 15 feet **(4.5m)** in **front** of the vehicle.

(4) Restriction of the horizontal angle of vision by window **frames**, corner and door posts, etc., shall not exceed 7 degrees per obstruction.

(5) Forward vision for the driver, looking through the windshield between the forward corner posts of the cab, shall be unobstructed.

EXCEPTION: A center post is acceptable if the width is under 2 inches (50 mm), and there are no blind areas at a distance of 40 feet (12 m) from the vehicle when viewed by the driver using both eyes and sitting in a normal operating position.

e. Cab interior noise level at the **driver's** ear position (eye height in paragraph (d) above) shall not exceed 8.5 dB(A) when measured in accordance with 49 Code of Federal Regulations (Transportation), Chapter III, Section 393.94, **10-** 1-89 Edition.

f. There shall be an adjustable rear view mirror with a flat glass area of at least 60 square inches (385 **cm²**) on each side of the vehicle. In addition to each flat mirror, a wide angle convex mirror of at least 7 square inches (45 **cm²**) shall be provided. Power adjustable and heated mirrors may be specified.

g. There shall be at least one **front** overhead or two side mounted (one each side of windshield) mirror(s) to provide the vehicle operator a clear view of the area in front of the vehicle that is not within the operator's direct view.

h. A cab roof hatch may be requested if manual roof turret operation **from** outside the cab is an

operational requirement for the particular turret specified.

29. EQUIPMENT. The following shall be provided as applicable:

- Air Conditioner, if specified.
- Cab Dome Light.
- Crew Seats(s) with **approved 3-point** seat belts.
- Driver's Enhanced Vision System (DEVS), if specified.
- Driver's Seat, up and down and fore and aft adjustable bucket type with approved seat belt.
- Heater/Defroster with 200 BTU output per cubic foot of cab space, with blower capacity equal to 1 cab volume per minute, with **fresh** air intake, and with ducts to windshield.
- Mounting provisions for SCBA at/in each seat.
- Siren/Audible Emergency Warning Device.
- Sun Visors • two or more.
- Windshield Deluge System, if specified.
- Windshield Washers • two or more with large capacity reservoir.
- Windshield Wipers • two or more with delayed and multi-speed capability.

30. INSTRUMENTS AND WARNING LIGHTS.

The following instruments and warning lights shall be provided in the cab as applicable:

- Air Pressure (brake and other air-driven accessories)
- Switch for Amber (yellow) Beacon Indicator.
- Complimentary Agent Tank • Charged Light.
- Differential Lock Indicator.
- Emergency Beacon Indicator.
- Engine Coolant Temperature.
- Engine Oil Pressure.
- Engine Tachometer(s).
- Foam Agent Tank Level Indicator with test switch.
- Foam Rump Pressure Indicator
- Fuel Level.
- Headlight Beam Indicator.
- High Reach Turret Deployment Indicator, if specified.
- Low Air Pressure Warning.
- Low oil pressure/high water temperature audible/visual alarm.
- Low engine coolant audible/visual alarm.
- Speedometer/Odometer.
- Side/slope inclinometer.
- Voltmeter • Expanded Scale.
- Water Pump Pressure.
- Water Tank Level Indicator with test switch.

Section 4. Driveline and Controls.

31. AXLES.

a. The axles shall be rated and certified as required by paragraphs **100.a.(1)** and 103.a as being suited for the intended use. The axle manufacturer's approved rating shall not be raised by the vehicle manufacturer to conform to the requirements of this specification.

b. Front and rear axles shall have adequate capacity to carry the fully loaded vehicle under **all** intended operating conditions. The maximum variation in axle tread shall not exceed 20 percent of the tire(s) sectional width at rated load.

c. Tractive power at each wheel shall be achieved by use of torque proportioning differentials or other suitable automatic devices which will ensure that each wheel of the vehicle is driven independently of the other wheels.

d. Front axles shall be equipped with steering drive ends designed to eliminate fluctuations in angular velocity of the wheels when cramped either **left** or right at all normal operating speeds.

32. BRAKE SYSTEM. A brake system shall be provided which has been tested and certified in accordance with the applicable requirements of paragraphs 104, 105, and **106**. The system shall include an all-wheel, split-circuit, power-assisted service brake, a modulatable emergency brake, and a parking brake.

a. **Air supply.** Vehicles supplied with air brakes shall have:

- (1) A compressor that shall:
 - (a) Be engine driven.

(b) Have capacity sufficient to increase air pressure in the supply and service reservoirs from 85 to 100 psi, (552 to 690 **kPa**) when the engine is operating at the vehicle manufacturer's maximum recommended revolutions per minute, in 25 seconds or less.

(c) Have the capacity for quick buildup of tank pressure **from** 5 psi (35 **kPa**) to the pressure required to release the spring brakes within 12 seconds.

(d) Have an automatic air drying system immediately downstream **from** the compressor.

(2) A service air reservoir that shall:

(a) Have a **volume** at least twelve times the total combined brake chamber volume at full stroke. If the reservoir volume, inclusive of supply lines, and air dryer volumes, is greater than the minimum required, proportionately longer buildup time is acceptable using the following formula:

Maximum Time (sec) = $\frac{\text{Actual reservoir capacity} \times 25}{\text{Required reservoir capacity}}$
and

(b) Have drain(s) and safety valve(s) as necessary for safe and efficient operation. Drains shall be at the lowest point of the vehicle.

(3) When specified by the purchaser, a provision for charging of air tanks by a **vehicle-mounted** auxiliary compressor. If an auxiliary compressor is specified, there shall be a pull-away electrical connection for plug-in station electricity to power the compressor.

(4) When specified by the purchaser, a **pull-away** air connection for charging **of air** tanks from an external air source.

(5) Visual and audible low **air** pressure warning devices. The low' pressure warning device shall be visible and audible from the inside of the cab.

b. Emergency Brake.

(1) The emergency brake shall be operable by the driver and shall be capable of modulation through the use of the service brake control.

(2) The emergency brake shall be capable of meeting the emergency brake stopping distance standard of Table 2, Performance Parameter 11, with the failure of a single part in the service brake system; other than a common valve, manifold, brake fluid housing, or a break chamber housing.

c. **Parking Brake.** The parking brake shall be operable by the driver and shall meet the parking brake holding performance standard of table 2, Performance Parameter 12.

d. **Service Brake.** A service brake powered by air, hydraulic, or air over hydraulic, which meets the applicable performance standards of table 2, shall be acceptable.

(1) A chamber shall be provided for each brake for each wheel and shall be mounted so that no part of any chamber hangs below the bottom of the axle on which it is mounted.

(2) The service brake shall be capable of providing at least one power-assisted stop with the vehicle engine off, which meets the service brake stopping distance standard of Table 2, Performance Parameter 10.

e. **Anti-Lock Brake System (ABS) - Option**
When specified by the purchaser, an all wheel ABS may be installed.

33. STEERING. All classes of vehicles shall have power-assisted steering.

a. The power assist shall have sufficient capacity so that no more than 15 pounds (6.8 kg) pull is necessary on the steering wheel rim to turn the vehicle wheels **from** lock to lock.

b. The design of the steering mechanism shall permit manual steering to bring the fully loaded vehicle to a safe stop after power-assist failure.

c. The vehicle shall perform as follows when driven on a steering pad around a **100-foot** (30 m) radius circle:

(1) With increasing speed, the steering angle shall increase; oversteer is not acceptable.

(2) The vehicle shall remain on the prescribed path until achieving a speed at least equal to

the standard specified in Table 2, Performance Parameter 3, applicable to its class.

d. The wall-to-wall turning diameter shall be no greater than three times the length of the vehicle.

34. SUSPENSION.

a. The axles and suspension system shall be such that the total unsprung weight of the vehicle will not be greater than 20 percent of the in-service vehicle gross weight.

b. Double acting hydraulic shock absorbers or an equivalent energy adsorbing device shall be provided for all axles or bogies as applicable.

c. Energy absorbing stops shall be installed so as to prevent damage to axles, drive shafts, engine oil pan, or any other portions of the chassis from bottoming.

35. TRANSFER CASE.

a. The transfer case shall be certified as suitable for the intended service in accordance with the requirements of paragraph 103.

b. A transfer case, which is either separate or integral with the transmission, shall be acceptable.

c. A single or a two-speed transfer case, as required to meet the performance requirements, shall be acceptable.

d. A transfer case which has either a front axle disconnect, a center differential with automatic or manual lockout, or an overriding clutch to compensate for difference in travel between front and rear wheels, shall be acceptable.

e. A transfer case which either engages the front and rear axles at all times, engages all axle's automatically, or which is driver-operator selectable to engage all-wheel drive and which will not allow the vehicle to stall as long as the tires of engaged axle(s) have traction, shall be acceptable.

36. TRANSMISSION.

a. The transmission shall be certified as suitable for the intended service in accordance with the requirements of paragraph 103.

b. The transmission shall be a continuous drive system. Either hydrostatic, hydrostatic/automatic, or automatic powershift, incorporating a torque converter with suitable torque ratio, shall be acceptable. The use of a transfer case to achieve the required performance is acceptable.

c. The 'transmission range selector shall have all positions clearly identified and back lit.

d. All drive-line components shall be of the same power ratings, i.e., no reduction in transfer through bulkheads.

e. The hydraulic system shall include oil pumps, oil filter and screens, a hydraulic control system, and an oil cooling system capable of limiting the transmission temperature to the maximum recommended by the transmission manufacturer.

f. In addition to 'meeting the acceleration, gradability, and top speed standards of paragraphs 5 1, 55, and 57, the transmission shall have sufficient spacing of intermediate ranges to provide a smooth, uniformly spaced transfer of power over the entire operating range.

g. When specified by the purchaser, an electronically controlled transmission shall be provided.

37. WHEELS AND TIRE ASSEMBLY.

a. The wheel and tire assembly, including the recommended tire inflation pressure, shall be certified in accordance with paragraph 103 as being suitable for the intended service.

b. Rim and tire rating shall conform to FMVSS 119, 120, and applicable tire and rim association recommendations for the type and size of tires furnished.

c. All tires, rims, and wheels shall be identical.

d. The tires shall provide good lateral stability during off-road mobility use in the terrain and climatic conditions expected at the intended airport. They shall also demonstrate safe on-road handling characteristics for operation on wet pavement.

e. Tires shall have a rated capacity at least equal to the load imposed. -on each tire measured at each wheel at the ground.

f. Tires shall be repairable and replaceable. There shall be a spare tire and wheel/rim assembly provided. with, but not mounted on the vehicle.

NOTE: The principle objective in the selection of the wheel and tire assemblies is to enhance the off-pavement mobility performance on the terrain encountered at the intended airport and, at the same

time, meet highway automotive performance standards. However, the off-pavement mobility and overall handling characteristics of a vehicle depend on a number of other factors in addition to tire selection. Additional information to aid the purchaser during specification development, as well as during consultations with the vehicle and tire manufacturers, is provided in appendix 2.

g. When specified by the purchaser tires shall include beadlocks.

Section 5. Electrical System.

38. COOLANT HEATER. An engine. coolant preheating device with thermostat shall be provided. It shall have sufficient capacity to maintain the engine at the manufacturer's recommended temperature for rapid starting and immediate high initial engine performance.

39. LIGHTING AND MARKING SYSTEM.-

a. The lighting and marking system, including reflectors, beacons, and clearance. lights, shall **satisfy** the applicable State and Federal **safety standards**.

b. The system shall include:

(1) Two or more sealed beam, halogen headlights with upper and lower driving beams.

(2) Spotlight mounted on any turret

(3) At least one taillight and one stoplight, or one combination taillight/stoplight on each side of the rear of the vehicle.

(4) Turn signals, **front** and rear, with **self-canceling** control, a visual as well as audible **indicator**, and a four-way flasher switch.

(5) Reflectors, markers, and clearance lights as applicable.

(6) Engine compartment light(s), non-glare type, arranged to illuminate both sides of the engine with switches(s) located in the engine compartment.

(7) Two backup lights, one installed on each side of the rear of the vehicle.

(8) One or more emergency flashing beacons as needed to meet visibility requirements. For recognition, the color red shall be used as stand-alone or in combination.

(9) Compartment light(s), non-glare type, arranged to illuminate the inside of all storage, maintenance access, and piping compartments.

c. Optional:

(1) Spotlights, quartz lights, fog lights, and area/service lighting, as specified, shall be included..

(2) If under normal local operational procedures there are circumstances where it is desirable to identify the status of an ARFF vehicle as other than an ARFF vehicle in emergency response status, at least one amber (yellow) flashing beacon, if requested, shall be provided in addition to the requirements of paragraph 39.b.

40. POWER SUPPLIES.

a. All components such as alternator, circuit breakers, etc., shall be as **waterproof/water** resistant as the state-of-the-art permits without the use of marine quality components. They shall be accessibly mounted **and protected** against exterior and engine heat.

b. One of the following electrical systems shall be provided

(1) **12-volt** electrical and starting.

(2) **12-volt electrical/24-volt** starting.

(3) **24-volt** electrical and starting.

c. For **12-volt** systems, an alternator shall be provided which has a minimum curb idle charging rate of 160 amps. For 24-volt systems, an alternator shall be provided which has a minimum curb idle charging rate of 80 amps. In either case, the alternator shall have a total current output capacity adequate to service the **full** operational electrical load. It shall have automatic regulation.

NOTE: Provisions to handle the additional load imposed by the winterization kit and/or air conditioning shall be included, when appropriate.

d. A weatherproof, grounded, polarized male plug (or plugs as, required to service the anticipated electrical load), suitable for receiving **110-volts AC** from an outside electrical supply, shall be provided.

(1) The plug(s) shall be mounted as specified by the purchaser.

(2) The **plug(s)** shall be wired to a built-in battery conditioner, the engine coolant pre-heating device, and the on-board air compressor, if specified.

(3) The plug(s) shall be designed to break-away or auto-eject.

(4) The matching female receptacle(s) shall be provided with the vehicle.

e. A battery system shall be provided as follows:

(1) The system shall contain at least two **12-volt** batteries connected in an approved manner.

(2) **Sufficient** cold cranking battery capacity shall be provided to meet the engine manufacturers recommendation for the lowest ambient starting temperature.

(3) If a **24-volt** starter is specified, **the** system shall include a solid-state battery circuit connection for the starter.

NOTE: Additional or larger capacity batteries may be necessary on vehicles equipped with the optional winterization kit.

(4) Batteries shall be securely mounted and protected against mechanical damage, water spray, and engine and exhaust heat.

f. If an enclosed battery compartment is provided, it shall be adequately ventilated. The battery connections and the batteries shall be readily accessible for removal and installation, as well as for examination, test, and maintenance. Roll out trays are an acceptable means of providing the required accessibility.

41. STARTER An electric starting device shall be provided. When operating under maximum load, the current draw shall not cause a voltage drop sufficient to adversely affect the function of other electrical equipment required to be operational during the start up process.

42. WIRING.

a. All wiring shall be numbered or color coded for proper identification, stranded conductors, and of a wire gauge commensurate with **the** anticipated maximum electrical load of the circuit.

b. Wires shall be insulated in accordance with the applicable standards of the Society of Automotive Engineers (SAE).

c. All connections shall be made with lugs or terminals mechanically secured to the conductors.

d. Wiring shall be protected **from** heat, oil, lubricants, firefighting agents, and physical damage and secured in place. Appropriate circuit breakers shall be provided. Circuit breaker panels shall be easily accessible for service. A diagram and labeling scheme shall be affixed to the inside of the removable or hinged panel over the breakers. A copy of this diagram shall also be included in the maintenance manual.

43. RADIO INTERFERENCE. Radio suppression of electrical system interference shall be in accordance with SAE J 551, **Standard on Performance Levels and Methods of Measurements of Electromagnetic Radiation from Vehicles and Devices (20-1000 MHz)** or an equivalent radio interference suppression standard.

Section 6. Engine and Accessories.

44. COOLING SYSTEM.

a. The vehicle manufacturer shall **certify** and provide appropriate documentation in accordance with paragraph **100.a.(2)** and 104, that the complete cooling system installation is suitable for the intended service.

b. The cooling system shall be provided with an automatic thermostat.

c. If a liquid-cooled system is provided, it shall:

(1) Have the capacity to stabilize the engine coolant temperature within the engine manufacturer's prescribed limits under operational conditions at the ambient temperature range normally encountered at the airport.

(2) Have drain cocks installed at the low point of the cooling system and at such other points as may be necessary to drain the system completely.

d. If an air-cooled system is provided, it shall have the capacity to stabilize the cylinder head and oil temperatures within the engine manufacturer's prescribed limits under operational conditions at the ambient temperature range normally encountered at the airport.

e. When provided, radiator or air inlet shutters shall be automatic and shall be "fail safe" in the open position.

45. EXHAUST SYSTEM.

a. The vehicle manufacturer shall **certify** that the exhaust system is suitable for the intended service.

b. The engine exhaust system shall be constructed of rust-resistant materials and shall be designed and installed so as to prevent the discharge of exhaust towards the ground, engine or cab air intake, or onto vehicle tires.

c. The exhaust system exit shall be located to prevent exhaust gasses from entering the closed cab under all operational conditions and shall include a muffler.

d. System components shall be protected from damage that could result from traversing off-road terrain.

e. Environmental requirements. ARFF vehicle/engines must meet all applicable Federal emission standards and regulations, e.g., **40** CFR Part 89, and EPA Off-Road emissions standards.

46. FUEL SYSTEM.

a. The vehicle manufacturer shall provide a fuel system which meets the engine manufacturer's installation approval and shall **certify** that the **fuel** system is suitable for the intended service.

b. All components shall be installed in a protected location or otherwise protected **from** operational damage, exhaust heat, and exposure to ground fires.

c. The fuel tank(s) shall:

(1) Be constructed of an approved material.

(2) Have an accessible drain plug.

(3) Have a filler pipe (accessible from outside of the cab) that is at least 2.25 inches (5.7 cm) in diameter.

(4) Have sufficient capacity to provide for a minimum of 30 miles (48 km) of highway travel at 45 mph (**73km/h**) average plus 2 hours of pumping at the full rated discharge.

(5) Be so located and mounted that it will prevent gravity feed.

d. An approved filter, mounted in an accessible location, shall be provided for each fuel supply line. The fuel supply line filter should be installed in such a manner that allows the **free** flow fueling of the vehicle without causing back ups and spills.

e. A heated fuel/water separator in connection with a winterization kit when specified by the purchaser shall be provided.

47. **GOVERNOR.** An engine governor, which will not adversely affect the automotive or extinguishing

agent system performance, shall be provided. It shall be set to limit engine speed so that it **cannot** exceed the maximum rpm recommended by the engine and driveline component manufacturers.

48. LUBRICATION.

a. The engine and transmission shall operate efficiently and without detrimental effect to any drive train components when lubricated with standard commercially available lubricants in accordance with recommendations of the engine and transmission manufacturers.

b. The engine oil and transmission fluid filters shall be full-flow type with replaceable spin-on element.

c. All moving parts requiring lubrication shall have a means provided for such lubrication. There shall be no pressure lubrication fittings where their normal use would damage grease seals or other parts.

d. The vehicle shall be serviced prior to delivery with lubricants, brake and hydraulic fluids, and a cooling system fluid suitable for use in the temperature range expected at the purchaser's airport.

49. POWER REQUIREMENT.

a. The engine(s) shall be an internal combustion diesel capable of developing the torque and horsepower needed to meet the automotive performance standards

of table 2 and the extinguishing agent discharge performance standards of table 3 for the applicable vehicle class. This power requirement shall be achieved without exceeding a "no load" governed speed at the peak of a certified gross brake horsepower (**bhp**) curve.

b. The engine shall be capable of meeting the, specified performance standards while operating on commercial grade diesel fuel.

50. WINTERIZATION -- OPTION;

a. Vehicles purchased for use in areas where it is common industrial practice to winterize vehicles shall have a winterization kit installed.

b. The winterization kit shall not detract from the performance of the vehicle or the firefighting system in ambient temperatures up to 115° F (43.5° C).

c. The winterization kit shall provide sufficient insulation and heating capacity, by means of hot circulating liquids and forced air heat exchangers, to permit satisfactory operation of the vehicle and **firefighting** systems for a period of at least 2 hours at ambient temperatures as low as -40°F (-40° C) with the vehicle **fully** operational and the engine running. At the end of this **2-hour** period, the vehicle shall be capable of successfully discharging its agent(s).

Section 7. Automotive Performance.

51. ACCELERATION. Each vehicle shall meet the applicable standard of Table 2, Performance Parameter 9.

52. BRAKE SYSTEM. The stopping and holding performance for each type of brake for each vehicle class shall meet the applicable standards of table 2, Performance Parameters 10, 11, and 12.

53. DYNAMIC AND STATIC STABILITY. The vehicle shall be able to:

a. Pump while rolling in both directions across a 20 percent (or 12°) side slope with extinguishing agents being discharged in any direction of turret azimuth at maximum rated turret capacity without

unanticipated stream interruption or vehicle instability. Pumping capacity shall supply an intermittent discharge as desired.

b. Remain stationary while headed in either direction across a 20 percent (or 12°) side slope and while the steering is being moved to a maximum turning angle both right and **left** without any vehicle instability.

c. Meet the applicable side slope stability standard of table 2, Performance Parameter 2.

d. Meet the applicable dynamic balance standard of Table 2, Performance Parameter 3.

54. ENVIRONMENTAL CONDITIONS. The vehicle shall be capable of withstanding the following conditions without detrimental effect to subsequent operation of the vehicle or any of the fire extinguishing systems:

- a. Dust particles as encountered in desert areas.
- b. The corrosive effects of salt fog.
- c. Material decay **from** fungus and mildew.
- d. Relative humidity up to 100 percent, as well as wind driven snow, sleet, rain, and vehicle **self-**splashing of water.
- e. Ambient temperature ranging **from** 32°F to 115° F (0°C to 43.5° C). (See paragraph 50 for winterization). If winterization is necessary, the temperature performance range shall extend to at least -40° F (-40° C).

55. GRADABILITY. The vehicle shall be able to:

- a. Ascend a smooth, dry, paved road having a 20 percent grade and maintain a speed of at least 8 mph (13 km/h).
- b. Ascend, stop, start, and continue ascending; and descend, stop, start, and continue descending on a 20 percent grade at a speed of at least 2 mph (3.2 km/h) with extinguishing agents being discharged at maximum rated capacity from the primary turret(s).
- c. Ascend and descend a dry, hard surface incline having a 50 percent grade at not less than 1 mph (1.6 km/h).
- d. Climb a vertical wall at least 18 inches (45 cm) high and negotiate terrain which will deflect the opposite wheels of the truck in alternatively contrary directions at least 14 inches without the remaining wheels losing traction.

56. OPERATIONAL RANGE. The fully loaded vehicle shall be able to:

- a. Operate continuously for 25 miles (40 km) at speeds up to 60 mph (96 km/h). The test route shall include agricultural lands, paved and unpaved roads, and grades typical of those encountered at the intended airport. During this performance evaluation, the

vehicle shall operate in all-wheel drive. At least 5 miles (8 km) of this operation shall be "off-road" travel.

- b. Operate on smooth, dry, level pavement through a range from 1 mph (1.6 km/h) to at least 10 mph (16 km/h) while discharging agents **from** the primary turret(s) at rated maximum capacity without interruption.

- c. Negotiate pooled water to a depth of 2 inches (5 cm) for a distance of at least 150 feet (45 m) at a speed of at least 40 mph (65 km/h) without engine flooding/stalling, loss of directional control, loss of braking, or electrical system(s) shorting.

- d. Operate for 10 minutes on dry, paved roadway at not more than 2 mph (3.2 km/h) at an engine speed that does not result in rough, irregular operation.

- e. Ascend dry, paved incline having an 8 percent grade for a distance of one-quarter mile (0.4 km) at a speed of not less than 20 mph (32 km/h).

57. TOP SPEED. The vehicle shall be able to consistently reach a top speed of 65 mph (104 km/h) and maintain a constant speed of at least 60 mph (96 km/h) on typical 'paved, level (grades of less than 1 percent) highway surfaces for a minimum distance of 20 miles (32 km) without showing overheat symptoms in any portion of the cooling system or power train.

58. OFF-ROAD HIGH MOBILITY SUSPENSIONS

An off-road, high mobility suspension system such as independent, active/reactive, and articulated suspensions, combined with lowering of the vehicle center of gravity, when specified:

- a. To include a central tire inflation/deflation system when specified, should support an off-road response at 35 mph when operating within the **runway** safety area over similar terrain in close proximity to the improved surface areas of the airfield. Typically this area has been moderately graded, has had most major obstruction removed, and has a sod cover.

- b. The applicable test for this performance is no more than 0.5 g rms acceleration at the seat of the vehicle when traversing an 8 inch (24 cm) half round at 15 mph (24 km/h).

59. DRIVER'S ENHANCED VISION SYSTEM (DEVS).

DEVS equipment can aid normal operations and provide an additional margin of safety for airport rescue response during periods of very low visibility operations. The DEVS equipment, when justified, will improve emergency response time during periods of low visibility, reduce the probability of secondary accidents often associated with poor weather and low visibility conditions, and improve command and control in the event of an aircraft incident or accident.

DEVS normally consists of three subsystems: night vision, navigation, and tracking. Because of the complexity of a DEVS, procurement and installation may be optional and by separate contract and comply with AC 150/5210-19.

a. Night vision. The purpose of the night vision subsystem is to improve the ARFF vehicle driver's ability to see at night and through smoke, fog, and adverse weather; it consists of a Forward Looking

InfraRed (FLIR) camera and a monitor in the cab. The vehicle shall be fitted with this subsystem.

b. **Navigation.** Using a differential GPS and a moving map display inside the cab, the navigation subsystem shows ARFF vehicle drivers their location, the accident site, and the path between to ensure rapid advance toward the site. The vehicle shall be fitted with this subsystem if specified by the purchaser.

c. **Tracking.** The vehicle tracking subsystem allows an overview of all vehicles at the command center and provides reliable digital communications with vehicles. It is comprised of a display at the command center and a digital radio datalink between the command center and vehicles. The vehicle shall be fitted with this subsystem if specified by the purchaser.

60. THROUGH 69. RESERVED.

Table 2. Automotive Performance Standards

PERFORMANCE PARAMETER FOR FULLY LOADED VEHICLE		VEHICLE CLASS			
		1	2	3	4
1.	Minimum Rated Water Capacity: (gallons)	1,000	1,500	2,500	3,000 and above
2.	Side Slope Stability: Degrees	30"	28°	28"	28°
	Percent Grade	58%	53%	53%	53%
3.	Dynamic Balance: Minimum Speed on 100 ft. Radius Circle (mph)	22	22	18.5	18.5
4.	Approach and Departure: Angles	30°	30°	30°	30°
5.	Interaxle Clearance: Angle	12"	12"	12°	12°
6.	Underbody Clearance:	18"	18"	18"	18"
7.	Underaxle Clearance at Differential Housing Bowl:	13"	13"	13"	13"
8.	Wall-to-Wall Turning Diameter:	Less than 3 x vehicle length			
9.	Maximum Acceleration Time from 0 to 50 mph: Seconds	25	30	40	45
10.	Service Brake: Stopping Distance From: 20 mph 40 mph	Maximum 35 feet Maximum 131 feet	40 160	40 feet 160 feet	
	Hold Fully Loaded Vehicle:	Minimum 50 percent grade Ascending and Descending			
11.	Emergency Brake: Stopping Distance From 40 mph	Maximum 288 Feet			
12.	Parking Brake: Hold Fully Loaded Vehicle:	Minimum 20 percent grade Ascending or descending			

Table 2M. **Automotive Performance** Standards (Metric)

PERFORMANCE PARAMETER FOR FULLY LOADED VEHICLE		VEHICLE CLASS			
		1	2	3	4
1.	Minimum Rated Water Capacity: (Liters)	3 785	5678	9463	11355 and above
2.	Side Slope Stability: Degrees	30"	28"	28"	28°
	Percent Grade	58%	53%	53%	53%
3.	Dynamic Balance: Minimum Speed on 30 m. Radius Circle (km/h)	35	35	29.5	29.5
4.	Approach and Departure: Angles	30°	30°	30°	30°
5.	Interaxle Clearance: Angle	12°	12"	12°	12"
6.	Underbody Clearance: (cm)	4 6	46	46	46
7.	Underaxle Clearance at Differential Housing Bowl: (cm)	33	33	33	33
8.	Wall-to-Wall Turning Diameter:-	Less than 3 x vehicle length			
9.	Maximum Acceleration Time from 0 to 80 km/h: Seconds	25	30	40	45
10.	Service Brake:				
	Stopping Distance From: 32 km/h	Maximum 11 m	14	14 m	
	64 km/h	Maximum 40 m	48	48 m	
	Hold Fully Loaded Vehicle:	Minimum 50 percent grade Ascending and Descending			
11.	Emergency Brake: Stopping Distance From 64 km/h	Maximum 86 m			
12.	Parking Brake: Hold Fully Loaded Vehicle:	Minimum 20 percent grade Ascending or descending			

CHAPTER 3. FIRE EXTINGUISHING SYSTEMS.

Section 1. Dry Chemical – Option.

70. AGENT CONTAINER(S) AND COMPONENTS.

a. The dry chemical container(s) shall:

(1) Be constructed and stamped in accordance with the **ASME** "Code for Unfired Pressure Vessels."

(2) Be certified in accordance with paragraph 103.c.

(3) Be able to hold at least **450** usable lbs (204 kg) of a potassium-based dry chemical fire extinguishing agent.

(4) Have an accessible fill opening that is easy to open **and** close and be provided with a compatible funnel to permit filling from dry chemical storage containers. The overall design shall allow filling without the removal of any of the extinguisher piping or any major component other than the fill cap.

(5) Have a pressure relief device conforming to appropriate **ASME** codes that will protect both the container and the low pressure piping.

(6) Have a gauge that indicates the pressure in the agent container at all times.

b. A check valve shall be provided in the gas piping to prevent the agent from being forced back into the propellant gas line.

c. A quick-acting agent system activation control shall be accessible to the seated driver **and** at least one other crew position. A similar control shall be located near the agent handline.

d. The agent pressurization system shall ensure fluidization of the dry chemical at the time of activation. Designs which include the automatic movement of the chemical or chemical container to help fluidize the contents shall also include a manual operating feature.

e. There shall be provisions for purging agent from all piping and hose after use without discharging the remaining chemical. Also, there shall be

provisions for the **depressurization** of the chemical container without the loss of the remaining chemical.

71. AGENT DELIVERY PIPING AND VALVES.

a. The piping, couplings, and valves shall be sized to provide the gas flow into the system and the agent flow out of the chemical container needed to meet the requirements of table 3, Performance Parameter 1 a and b.

b. All piping and fittings shall conform to the appropriate **ASME** code. The completed system shall be designed and installed so as to withstand the recommended working pressure of the system.

c. The integrity of the installed discharge piping shall be tested at a pressure equal to 150 percent of the system working pressure.

d. Material for all piping, couplings, and valves shall be resistant to agent, weather, and galvanic corrosion.

e. Piping shall be securely mounted and provided with flexible couplings where needed to minimize stress.

f. When more than one agent discharge outlet is provided, the size and design of piping, pressure regulators and fittings shall provide equal flow to each **handline** nozzle, regardless of the location of the hose reel or the number of lines placed in operation.

g. All valves shall be quarter-turn type, selected for ease of operation and **freedom from** leaks.

72. PROPELLANT, PROPELLANT CONTAINERS AND COMPONENTS.

a. The propellant gas shall be either dry nitrogen or dry air. Sufficient container capacity shall be provided to ensure enough gas to discharge all of the agent and to permit purging of all pipes and hose lines **after** use.

b. All propellant gas cylinders and valves shall comply with US Department of Transportation (DOT) requirements. Cylinders shall bear the DOT marking,

including evidence of a current hydrostatic test and shall be certified in accordance with paragraph 103.f.

c. Pressure gages shall be provided which will indicate the pressure on the propellant gas system downstream of the pressure regulator and in the propellant cylinders at all times.

d. Cylinder valves, gages, and piping shall be arranged or protected to preclude accidental mechanical damage during **firefighting** operations.

e. The pressure reduction system shall automatically reduce the normal storage cylinder pressure to (and hold it at) the designed operating pressure of the dry chemical container. The regulator may be of a type without pressure indicating gages.

Section 2. Halatron I or an Acceptable Substitute – Option.

73. AGENT CONTAINER AND COMPONENTS.

a. The container material shall be suitable for the storage of Halatron I or an acceptable substitute and shall be constructed in accordance with ASME “Code for Unfired pressure Vessels” and shall be so stamped.

(1) The capacity of the container shall be as specified by the purchaser.

(2) A fill coupling of sufficient size to allow agent tank filling, without loss of agent, shall be provided. It shall permit tank filling without the removal/disconnection of any piping or **major** components. The fill coupling shall be provided with a dust cap secured to the coupling with a safety chain.

(3) A means shall be provided to determine the contents of the container as a guide in recharging partial loads and to prevent overfilling of the tank.

(4) The container shall have a gauge that indicates the pressure in the agent container at all times.

b. A means of pressure relief conforming to appropriate ASME codes shall be provided for the

(1) Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

(2) All pressure regulating devices shall be sealed or pinned at the designed operating pressures **after** final adjustment by the system manufacturer and shall be certified in accordance with paragraph 103.g.

(3) Regulators must be of a high flow variety which allows a rapid build-up time for system pressure for a full system charge and operation.

f. When specified, a hoist shall be provided to aid in propellant cylinder removal. The hoist shall be manual or electric, as specified by the purchaser.

chemical container and piping. A check valve shall be provided in the gas piping to prevent agent from being forced back into the propellant gas line.

c. Provisions shall be made for the purging of agent from the discharge piping and hose without discharging the chemical remaining in the container. Provisions also shall be made for the **depressurization** of the chemical container without the loss of the remaining chemical.

74. AGENT DELIVERY PIPING AND VALVES.

a. The piping, couplings, and valves shall be sized to provide the gas flow into the system and the agent flow out of the chemical container needed to meet the requirements of table 3, Performance Parameter 2.

b. The applicable requirements of paragraph 71.b through 71.g also apply.

75. PROPELLANT, PROPELLANT CONTAINERS, AND COMPONENTS. The requirements of paragraph 72 also apply here.

Section 3. Foam Concentrate System.

76. CONCENTRATE PROPORTIONER

a. A foam concentrate proportioning system shall be provided to control the ratio of foam concentrate to water in the foam/water solution being discharged from all orifices normally used for ARFF operations.

(1) The proportioning system for a 6 percent concentrate shall be sufficiently accurate to provide for the discharge of finished foam within the range of 5.5 percent to 7.0 percent foam concentrate in the discharged foam/water solution.

(2) If a foam concentrate other than 6 percent is used, the precision range shall be modified in direct ratio. Thus, a 3 percent concentrate shall be in the 2.8 to 3.5 percent concentrate range in the discharged solution. A 1 percent concentrate shall be in the 0.92 to 1.2 percent concentrate range in the discharged solution.

b. This precision shall be maintained for all individual discharges, and for the maximum simultaneous discharge rate of all turrets, handlines, and ground, sweeps while delivering the quantity of concentrate required to meet the agent discharge requirements of table 3.

77. CONCENTRATE RESERVOIR AND PIPING.

a. Materials used in reservoir construction and piping shall be compatible with the foam concentrate, the foam/water solution, and water.

b. A rigid or a flexible foam concentrate reservoir shall be acceptable.

(1) If separate, from the water tank, the reservoir shall be mounted in a manner that limits the transfer of the torsional strains from the chassis to the reservoir.

(2) The reservoir shall be separate and distinct from the crew compartment, engine compartment, and chassis. It shall be removable as a unit.

(3) The reservoir(s) shall have a working capacity sufficient for two tanks of water based on the use of 6 percent foam concentrate. If a 3 percent foam

concentrate is specified, the working capacity of the foam tank shall not exceed that required to mix with four tanks of water or six tanks of water with a 1 percent concentrate. The actual capacity needed to comply with the performance requirements will depend on the water tank capacity and the proportioner accuracy.

(4) A flexible reservoir shall be supported in a manner that does not depend on the fluid level in either the foam or water reservoirs for its structural integrity.

(5) Provisions shall be made for access for internal, and external inspection and service. Reservoirs, large enough to require baffles, shall be provided with access to each baffled compartment. NOTE: In case of life time warranted poly tanks, there is no need to provide inspection access unless specified by the purchaser.

(6) The reservoir shall be fitted with a sump, complete with antiscum baffles, and a 1.5 inch (38 mm) minimum diameter drain with a valve and an accessible control.

(7) The reservoir outlet(s) shall be located above the bottom of the sump and shall permit a continuous flow of foam concentrate to the proportioning system with that system supporting the discharge standards of table 3 during the discharge of two consecutive tanks of water.

(8) Reservoirs shall be vented to permit the required fill rate without exceeding the design working pressure and to permit emptying at the maximum design flow rate without danger of collapse. The vent outlets shall be directed so as to prevent spillage of foam concentrate on vehicle components.

c. The fill system shall be capable of delivering foam concentrate to the reservoir at a rate at least equal to the maximum use rate of the foam proportioning system.

(1) Bottom fill connection(s) shall be provided and shall be no more than 60 inches (150 cm) from the ground. The inlets shall be fitted with stainless steel strainers of 1/4 inch (6 mm) mesh, and shall have check valves or be so constructed that no more than .25 gal (1 L) of foam is lost from the

reservoir during connection or disconnection of the foam resupply line. An isolation valve shall be installed on the foam line as it leaves the tank to allow easy maintenance on foam plumbing.

(2) A top fill opening shall be provided which shall be equipped with a No. 10 gauge mesh, corrosion resistant (stainless steel or equal) screen, and a sufficient number of **5-gallon** agent container openers to permit the rapid emptying of **5-gallon** containers into the reservoir(s). The fill line from the trough shall

introduce foam concentrate into the reservoir so as to minimize foaming.

d. The foam concentrate piping shall be sized to permit the flow rates needed to meet the agent discharge requirements of table 3 and shall be arranged to prevent water from entering the foam reservoir.

e. The foam concentrate piping shall be so arranged that the entire system, including any foam concentrate pumps, can be flushed with water from the water tank without contaminating the foam reservoir.

Section 4. Water System.

78. PIPING, COUPLINGS, CONNECTIONS, AND VALVES.

a. A pressure relief valve shall be fitted to the discharge system which is set to ensure discharge standards can be met and that surges above the designed operating pressure are relieved.

b. All suction and discharge outlets shall have National (American) Standard fire hose coupling threads.

EXCEPTION: Adapters, securely attached to each outlet, shall be acceptable if local **couplings** are not **National (American) Standards as specified in NFPA 1963, Standard for Screw' Threads and Gaskets for Fire Hose Connections, and the outlet(s) with adapters do not add to the width or length of the vehicle.**

c. All water system piping on the suction side of the pump shall be tested to detect leaks. All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 150 percent of the normal system operating pressure.

d. If two pumps are used, they shall be arranged in parallel with a manifold so that either or both may supply any discharge outlet at the required operating pressure. During single pump operation, total discharge capacity may be proportionally reduced.

e. Piping, couplings, and valves shall be sized to provide agent flow to all discharge devices operating to the applicable standards of table 3.

f. A drain shall be provided in the suction system at the lowest point with a valve for draining all of the liquid **from** the pumping system.

g. A drainage system, with collector tubing from the low points on 'pump(s) and piping, shall be provided.

h. All valves shall be quarter-turn type and selected for ease of operation and leak-free design.

i. Material **for** all piping, couplings, and valves shall be selected to avoid corrosion.

j. Piping shall be securely mounted and provided with **flexible** couplings to minimize stress from chassis flexing. Union, gasketed, or victaulic fittings shall be provided where required to facilitate removal of piping.

79. WATER PUMPS AND PUMP DRIVE.

a. The water pump drive, if common with the vehicle drive, shall have **sufficient** power to meet the automotive performance and foam/water agent discharge standards of tables 2 and 3, individually and simultaneously, as applicable.

b. If an independent pump engine is used, it shall:

(1) Have fuel, electrical, lubrication, hydraulic, and coolant requirements that are compatible with the chassis engine.

(2) Have **sufficient** power capacity to meet the foam/water agent discharge standards of table 3

under all normal vehicle operational modes and environmental conditions.

(3) Be certified by the manufacturer as suitable for the intended service.

c. The water pump(s) shall:

(1) Have sufficient capacity to supply the foam/water solution at the pressures and volumes required to simultaneously fulfill the discharge standards of table 3.

(2) Be a **centrifugal** type, single or multiple stage shall be acceptable.

(3) Be gravity primed **from** the **vehicle** reservoir, regardless of the water level in the tank, and the associated piping shall be designed and installed so as to prevent air lock. NOTE: A hydrant pressure can only be used for resupply of tank system.

EXCEPTION: If design considerations require the water pump to be mounted above the bottom of the water tank, it shall have an automatic priming system and provisions shall be made to prevent the loss of prime during intermittent pumping operations, **particularly** for the situation where the water level falls below the pump inlet level.

(4) Be constructed of materials which are compatible with water, water/foam solutions, and foam concentrate.

d. The design, construction, and installation of the pump, pump drive system, and associated piping and controls shall:

(1) Allow the vehicle motive drive to be engaged while pumping operations are in progress without damage to or cause lurching of the vehicle.

(2) Permit the engagement of the pump at any engine and vehicle speed combination encountered during a normal vehicle operations profile.

(3) Allow pump engagement **during** vehicle operations, without engine stall and without causing more than a slight and momentary reduction in the engine speed, and not cause damage to any of the components.

e. A means **shall** be provided to automatically prevent the water pump and, if applicable, the foam **pump** from overheating while engaged and operating at zero discharge.

80. WATER RESERVOIR AND PIPING.

a. The water reservoir shall:

(1) Have a minimum rated capacity (working capacity) which meets the water quantity standard presented in table 3, Performance Parameter 8.

(2) Be constructed of material suitable for service with the water intended to be used by the purchaser.

(3) Have sufficient longitudinal and transverse baffles to ensure that individual baffled compartments do not exceed 350 gallons (1 324 L) and baffle openings are not in-lines.

(4) Be equipped with removable manhole covers, plates, or removable tops to permit access to the sump.

(5) Be fitted with a sump, complete with antiwhirl baffles, a **2.5-inch** (6.5 cm) low point drain, an isolation valve, and a quarter-turn valve which has an accessible handle.

(6) Have a top-fill opening diameter of at least 8 inches (20 cm), a screen with maximum 1/4 inch (6.4 mm) mesh and a gasketed, latchable cap.

(7) Be vented to permit filling and overfilling at the rate specified in paragraph **80.c** and discharging in accordance with table 3, without exceeding the design operating pressure or causing the reservoir to collapse. Overflow shall be directed to the ground.

b. The discharge piping shall be sized to **allow** sufficient water to the pump for the simultaneous operation of all turrets, ground sweeps, handlines, and undertruck nozzles, at the applicable discharge rates specified in table 3.

c. Each connection and corresponding fill piping shall be sized to permit filling in no more than 2 minutes when the supply source provides sufficient volume at 80 psi (5.5 bar) at the reservoir fill connection.

Section 5. Handlines, Reels, and- Compartments.

81. HANDLINES.

a. There shall be a minimum of two handlines with nozzles for the discharge of foam/water **which** may be of the woven jacket or reeled type (can be reeled swing out type hoses). These handlines shall not be on the same side of the vehicle. If an optional complementary agent extinguishing system is to be included, the **handline** may be "twinned" with one or both of the reeled foam/water handlines, or included as a separate **handline** as specified by the purchaser. It may be fitted with nozzles which entrain or capture dry chemical application within the master stream of 'water agent flow.

b. If selected by the purchaser, the reeled complementary and foam/water hand lines shall:

(1) Be able to meet the discharge performance standard of table 3, Performance Parameter 3, with the hose fully unrolled.

(2) Have at least 150 feet (45 m) of hose on each foam/water reel or each dedicated complementary agent reel. A complementary twinned agent reel shall have at least 100 feet (30m) of hose.

(3) Be equipped with a variable pattern, N shutoff-type nozzle which will meet the discharge and pattern performance standard of table 3, Performance Parameter 3, for both foam and water. Be certified to meet NFPA 1964, Standard for Spray Nozzles and Tips.

(4) Electric rewind shall be provided for each **hosereel** when specified by the purchaser.

c. If specified by the purchaser, the woven jacket foam/water hand lines shall:

(1) Be able to meet **the** discharge performance standard of table 3, Performance Parameter 4, with the hose fully stretched.

(2) Have at least 150 **ft.** (45 m) of hose in each handline.

(3) Be equipped with a variable pattern, N shutoff-type nozzle which will meet the discharge and pattern performance standard of table 3, Performance

parameter 4, for both foam and water. Be certified to meet NFPA 1964, Standard for Spray Nozzles and Tips

(4) Meet the requirements of NFPA 1961, Standard for Fire Hose.

(5) Be stored and **preconnected** in a hose compartment.

NOTE: See the "NOTE" following paragraph 1 **10.e.(13)** for a clarification of the **handline** test discharge -rate conditions.

82. WOVEN JACKET HOSE AND REEL HOSE COMPARTMENTS.

a. Each woven jacket hose compartment shall:

(1) Have capacity for at least 150 ft. (45 m) of **1.50-in.** (38 mm) multiple jacket hose.

(2) Be fabricated **from** corrosion-resistant material and designed and constructed to drain by gravity.'

(3) Be smooth and **free from** all projections that might damage the hose.

(4) Have NO OTHER equipment mounted or located where it will obstruct the removal of the hose.

(5) Be not more than 6 ft. (1.8 m) above the ground.

(6) Have located in or adjacent to it a manually operated quarter-turn ball-type valve which controls the flow to each handline.

(7) Be weather-tight and fitted with a closure that can be secured in either the open or closed position.

b. Each hose reel shall:

(1) Be positioned to permit hose line removal by one person from any position in a 120° horizontal sector in front of the reel.

(2) Be equipped with a friction brake that will prevent the hose from unrolling when the vehicle is in motion.

(3) Be equipped with a power rewind with manual override.

(4) Have located adjacent to it a manually operated quarter-turn ball-type valve which controls the flow to each handline.

c. Each hose reel compartment shall:

(1) Be provided with hose rollers on the left, right, and bottom edges of the reel compartment.

(2) Be weather-tight and fitted with a closure that can be secured in either the open or closed position.

Section 6. Ground Sweep, Turrets, and Undertruck Nozzles.

83. BUMPER TURRET. A power joystick controlled bumper turret shall be provided which meets the discharge and pattern standards of Table 3, Performance Parameter 7. It shall:

a. Have controls located in the cab within easy reach of the driver and a second crew member.

b. Be capable of rotating 90 degree to either side of center.

c. Have a total traverse of 180 degree.

d. Be capable of elevation at least 45 degree above the horizontal.

e. Be capable of automatic oscillation through the total traverse of 180° with controls to adjust the oscillation angles.

84. PRIMARY TURRET.

a. A manual or power-assisted turret shall be acceptable.

b. One primary turret which meets the discharge and pattern standards of Table 3, Performance Parameter 5, shall be provided. It shall:

(1) Be capable of rotating at least 105 percent to either side of center.

(2) Have a total traverse of at least 210 degrees.

(3) Be capable of being elevated at least 45° above the horizontal.

(4) Be capable of both high and low flow agent distribution with a means to indicate to

driver/operator which flow pressure is being distributed.

(5) May be fitted with nozzles which entrain or capture dry chemical application within the master stream of water agent flow.

(6) Roof mounted turrets (Optional flow) may have flow rates reduced by 250 GPM increment and elect to raise ground bumper turret flow rate by 250 GPM proportionally.

c. Where turret control is at the platform, operating forces shall be less than 30 lbs. (13.5 kgf). All power-assisted controls shall have identical operating characteristics. Manual controls and overrides shall be provided at the turret platform.

d. Where turret control is in the cab, operating forces shall be less than 30 lbs. (13.5 kgf). A turret follower or other device to indicate turret azimuth and elevation shall be provided.

e. If the vehicle is equipped with a ground sweep, turrets with variable flow rates of 500 gpm (1 893 L/min) or more shall be designed to permit selection of either 50 percent or 100 percent of the rated turret discharge.

f. If the vehicle is equipped with a bumper turret with a maximum flow rate of 300 gpm (1 137 L/m), the primary turret may be specified by the purchaser to have either a single or a dual flow rate discharge capacity.

85. HIGH-REACH, EXTENDABLE TURRET: OPTION. The need for a practical, high-rise/high-reach/elevating/extendible waterway (device) to replace conventional turrets as the principle fire extinguishing agent applicator on ARFF vehicles has been recognized for over two decades. Equipment intended to provide

this capability for ARFF vehicles has been under development for the past decade, and devices which are operationally practical in the ARFF service environment have become available.

a. If selected as a substitute for the primary turret by the purchaser, the device provided shall:

(1) meet the requirements of paragraphs 8-5.2, General Requirements and 8-5.3, Capacity Ratings in NFPA 190 1- 199 I, Section 8-5, Water Tower,

EXCEPTION: The provisions of Paragraph 8.5.3.1 do not apply; see 85.a.(3) below.

(2) meet the **functional** requirements of paragraph 84.a-c for a conventional roof turret except that the minimum rotation of the agent stream either side of center shall be at least 105 degree, and have a total traverse of at least 2 10 degree, with horizontal rotation of the boom assembly,

(3) meet the primary water-foam agent turret discharge requirements of Table 3, Items 5.a and b.(1)-(3) for the applicable vehicle class while in bedded position,

(4) meet the foam quality standards of table 4 for the applicable foam applicator and foam type,

(5) function during ARFF operations without the need for outriggers or other ground. contact stabilizers which would render the vehicle immobile or hinder its maneuverability,

(6) achieve the elevation and reach needed to service the highest tail mounted engine for the type of **aircraft** being protected and start application of agent within 30 seconds of activation of the deployment cycle. **The** high rise, telescoping, **and/or** articulating movement of the boom/tower shall be accomplished with not more than two adjacent. lever controls and may be manual or **automated** for **pre-selected** positioning of the elevation and reach. If automated, these **functions** shall be provided with a manual override positioning capability,

(7) be capable of applying agent to the interior of the aircraft through cargo bay openings, passenger doorways, and emergency exits on the type of aircraft being protected while the aircraft is in either the gear-up or gear-down landing position, with the

vehicle **positioned** a horizontal distance of twenty feet **from** the aircraft,

(8) have a range of motion so **as** to permit positioning of the nozzle to direct a firefighting **agent** stream at least 90 degree to the longitudinal axis of the fuselage for interior **fire** extinguishment,

(9) be capable of providing (the boom mechanism) for horizontal movement along the **aircraft** of at least **30°** left and right of the vehicle centerline so as not to require repositioning or movement of **the** ARFF vehicle. This horizontal rotation must be accomplished without the deployment of stabilizers or outriggers. which might cause, a delay in positioning or emergency movement of the **rescue** vehicle,

(10) have sufficient back-up **systems to** allow for override of the single lever boom control and hydraulic system (or other, power source> if **the** primary system becomes disabled, and

(11) may be fitted with nozzles which entrain or capture dry chemical application within the master stream of water. **agent flow.**

b. If **specified** by the purchaser as a substitute for a roof-mounted primary **water/foam** and a dry chemical turret, i.e., to function as a dual agent turret system, the device shall also be capable of **meeting** the agent discharge performance of Table 3, Item 9.a-c while in the bedded position.

c. For man-rated or **nonman-rated** devices an adjustable or dual flow rate nozzle shall be provided to which will allow flow rates and patterns suitable for interior aircraft **firefighting**.

d. If a man-rated,, device is specified by the purchaser, access and load **ratings shall** be adequate to **allow a properly** equipped **fire** lighter to use the, tools and water/foam or auxiliary agent handlines necessary to perform the **functions** associated with interior aircraft fire fighting and fight tail mounted engine fires from the **fully** extended device. If the device, is equipped with a ladder attached to the boom or sections for continuous egress, it shall meet the requirements of paragraphs 8-5.2.5.1 through 8-5.2.5.7 of NFPA 1901-1991.

e. If a nonman-rated device is **specified by the** purchaser, it shall be fitted with the tools and devices

needed for a driver or another operator to remotely perform the interior aircraft and tail mounted engine **firefighting** functions. The following are examples of such tools/devices:

(1) Auxiliary agent line - capable of discharging either dry chemical or Halotron I or approved equivalent through an appropriate nozzle while the device is extended out and up to its maximum operational reach. It shall meet the minimum auxiliary agent flow rate and pattern requirements of Table 3.

(2) Remote optics - capable of sufficient resolution to permit overall **fire** scene surveillance when fully extended and to provide the driver/operator with the detail needed for placement of the penetration device on the aircraft hull for proper piercing. The camera and associated lighting shall be designed and installed for exterior environmental operating conditions normally encountered by **ARFF** vehicles. A monitor (7" or larger) shall be cab-mounted in a road-worthy manner and shall be readily accessible to the driver/operator.

(3) Skin penetrator/agent applicator - for penetration of the fuselage to access passenger cabin or

cargo compartment fires from outside the aircraft. It shall be **moveable** in conjunction with the water/foam nozzle to allow proper placement with the nozzle control. It shall meet the minimum water/foam flow rate **and pattern** requirements of table 3, Items 4.a and c.

86. UNDERTRUCK NOZZLES -- OPTION. If requested by the purchaser, sufficient foam/water undertruck nozzles shall be provided so that the combined spray pattern will cover the total undertruck area as well as the inner sides of the wheels and tires.

87. DUAL AGENT TURRET--OPTION. If specified by the purchaser, it shall:

a. meet the applicable discharge and pattern standards of table 3, performance parameters 5 and 9,

b. be capable of being depressed to discharge foam/water agent to within 30 feet (**9m**) of the **front** bumper of the vehicle at full output using dispersed stream.

Section 7. Agent System Performance.

88. COMPLEMENTARY AGENT SYSTEM -- OPTION.

a. If a dry chemical system is provided, it shall meet the standards of table 3, Performance Parameter 1.

b. If a Halotron I or approved equivalent substitute system is provided, it **shall** meet the standards of Table 3, Performance Parameter 2.

89. WATER/FOAM AGENT APPLICATORS.

a. Each water/foam agent **handline** shall be capable of delivering a finished foam solution which meets the applicable rate, range, and pattern standards of table 3, Performance Parameters 3 or 4.

b. Each water/foam agent **handline** shall deliver finished foam of a quality which meets the applicable standards of table 4.

c. Each water/foam agent turret or ground sweep shall be capable of delivering a finished foam solution which meets the applicable rate, range, and pattern standards of Table 3, Performance Parameters 5, 6, or 7, as applicable.

d. Each water/foam agent turret or ground sweep shall deliver a finished foam of a quality which meets the applicable standards of Table 4.

NOTE: All water/foam applicator performance requirements are based on the assumption that foam used to perform the tests is an approved foam concentrate, e.g., will pass the military AFFF foam specification 50 ft² fire test and the burnback resistance test.

90. THROUGH 99. RESERVED.

Table 3. Extinguishing Agent System Performance Standards.

AGENT SYSTEM PERFORMANCE PARAMETER		VEHICLE CLASS			
		1	2	3	4
1.	Dry Chemical Handline: a. Discharge Rate b. Range	≥ 5 lbs per sec ≤ 7 lbs per sec At least 25 feet			
2.	Halotron I or approved equivalent Handline: a. Discharge Rate b. Range	≥ 5 lbs per sec ≤ 7 lbs per sec At least 25 feet			
3.	Reeled Water/Foam Handline: a. Nozzle Flow Rate: $\pm 5\%$ b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 60 gpm (or 95gpm for 1.25 in. i.d hose) ≥ 50 ft reach ≥ 20 ft reach and ≥ 15 ft wide			
4.	Woven Jacket Water/Foam Handline: a. Nozzle Flow Rate: $\pm 5\%$ b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 95 gpm ≥ 65 ft reach ≥ 20 ft reach and ≥ 15 ft wide			
5.	Turret Discharge: a. *Flow Rate: (gpm), (-0%, +10%) b. Stream Pattern/Distances (1) Straight/Far Point (ft) (2) Dispersed/Far Point (ft) (3) Dispersed/Width (ft)	500 160 60 35	750 190 65 35	1,000 230 70 35	1,200 250 75 35
6.	Ground Sweep: a. Flow Rate: (gallons/minute) b. Flat Pattern Distances: (1) Far Point (ft) (2) Width (ft)	At least 100 (-0%, +10%)			
		≥ 30 ≥ 12	≥ 30 ≥ 12	≥ 30 ≥ 12	≥ 30 ≥ 12
7.	Bumper Turret: a. *Flow Rate: (gpm), (-0%, +10%) b. Flat Patter Distances: (1) Near Point (2) Width (ft) (3) Far Point (ft) c. Straight Stream:	250	300	300	300
		\leq Within 30 feet of front bumper			
		≥ 20 ≥ 50	≥ 30 ≥ 50	≥ 30 ≥ 50	≥ 30 ≥ 50
		Range at least 150 feet			
8.	Water Tank: Minimum Rate Capacity	1,000	1,500	2,500	3,000 and above
Percent Deliverable:					
a. On level,		100%	100%	100%	100%
b. On 20% side slope, and on		75%	75%	75%	75%
c. 30% ascending/descending grade		75%	75%	75%	75%
9.	Dry Chemical Turret Discharge: a. Flow Rate: b. Range, Far Point: c. Width:	≥ 16 lbs per second ≥ 100 ft ≥ 17 ft			

***NOTE:** Roof mounted turrets may have flow rates reduced by up to 30% and elect to raise ground bumper turrets rate increased proportionally. For example, Class 2 , Turret 750 down to (525), Bumper 300 up to (525).

Table 3M. Extinguishing Agent System Performance Standards (Metric) .

AGENT SYSTEM PERFORMANCE PARAMETER		VEHICLE CLASS			
		1	2	3	4
1.	Dry Chemical Handline: a. Discharge Rate b. Range	≥ 2.35 kg per sec ≤ 3.3 kg per sec At least 7.5 m			
2.	Halotron I or approved equivalent Handline: a. Discharge Rate b. Range	≥ 2.3 kg per sec ≤ 3.3 kg per sec At least 7.5 m			
3.	Reeled Water/Foam Handline: a. Nozzle Flow Rate: $\pm 5\%$ b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 227 Lpm ≥ 15 m reach ≥ 6 m reach and ≥ 4.6 m wide			
4.	Woven Jacket Water/Foam Handline: a. Nozzle Flow Rate: $\pm 5\%$ b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 360 Lpm ≥ 19.5 m reach ≥ 6 m reach and ≥ 4.6 m wide			
5.	Turret Discharge: a. *Flow Rate: (Lpm), (-0%, +10%) b. Stream Pattern/Distances (1) Straight/Par Point (m) (2) Dispersed/Par Point (m) (3) Dispersed/Width (m)	1,893 49 18 10.5	2,839 58 19.5 10.5	3,785 70 21 10.5	4,542 75 22.5 10.5
6.	Ground Sweep: a. Flow Rate: (liters/minute) b. Flat Pattern Distances: (1) Far Point (m) (2) Width (m)	At least 379 (-0%, +10%)			
		≥ 9 ≥ 3.6	≥ 9 ≥ 3.6	≥ 9 ≥ 3.6	≥ 9 ≥ 3.6
7.	Bumper Turret: a. *Flow Rate: (Lpm), (-0%, +10%) b. Flat Patter Distances: (1) Near Point (2) Width (m) (3) Far Point (m) c. Straight Stream:	946	1,135	1,135	1,135
		\leq Within 9 meters of front bumper			
		≥ 6 ≥ 15	≥ 9 ≥ 15	≥ 9 ≥ 15	≥ 9 ≥ 15
8.	Water Tank: Minimum Rated Capacity (liters) Percent Deliverable: a. On level, b. On 20% side slope, and on c. 30% ascending/descending grade.	3,785	5,678	9,463	11,355 and above
		100% 75% 75%	100% 75% 75%	100% 75% 75%	100% 75% 75%
9.	Dry Chemical Turret Discharge: a. Flow Rate: b. Range, Far Point: c. Width:	≥ 7 kg. per second ≥ 30 meters ≥ 5 meters			

***NOTE:** Roof mounted turrets may have flow rates reduced by up to 30% and elect to raise ground bumper turrets rate increased proportionally. For example, Class 2 , Turret 750 down to (525), Bumper 300 up to (525).

Table 4. Foam Quality Standards.

Foam Concentrate Type (1) (2)						
Protein and Fluoroprotein Air-Aspirated			Aqueous-Film-Forming-Foam and Film-Forming Fluoroprotein Foam			
			Air-aspirated		Nonaspirated	
	Expansion Ratio (Range)	Minimum 25% Drain Time, (minutes)	Minimum Expansion Ratio	Minimum 25% Drain Time (minutes)	Minimum Expansion Ratio	Minimum 25% Drain Time (minutes)
Ground Sweeps	8-12	5	5	4	3	1
Handlines	8-12	5	5	4	3	1
Turrets	8-12	5	5	4	3	1

- (1) *The foams used to test the vehicle foam system performance are assumed to be foams that meet the industry standards for acceptable aircraft firefighting foams. For example, the non-film forming foams, e.g., protein/fluoroprotein foams, must be capable of passing Underwriters Standard UL-162 (Type 3 Application) and the film-forming-foams must be capable of passing at least the 50 ft² fire extinguishment test and the burnback resistance test of MIL-F-24385.*
- (2) *Foams that are labeled as "universal", "multi-purpose", "polar solvent", "3%/6%" or "alcohol foams" should not be used in an airport ARFF vehicle unless the ARFF vehicle is specifically designed with a proportioning system, foam storage tank, and piping intended to use this type of agent.*

CHAPTER 4. QUALITY ASSURANCE.

Section 1. General Consideration.

100. CRITERIA FOR VEHICLE ACCEPTANCE. Compliance with this guide specification shall be documented by one more of the following methods:

a. Manufacturer's Certification.

(1) The ARFF vehicle manufacturer shall comply with this requirement by providing a signed, component manufacturer's application approval for the specific components listed in paragraph 103. The signed application approvals or a clear copy of the original shall be made part of the vehicle documentation package.

(2) The ARFF vehicle manufacturer shall provide a written certification that the specific subsystems listed* in paragraph 104 comply with the applicable performance, design, or construction requirements of this guide specification. A signed copy of the certification shall be made part of the vehicle documentation.

b. Prototype Vehicle Tests.

(1) The tests specified in paragraph 105 shall be conducted by the manufacturer on the "first article," i.e., prototype vehicle, produced to meet the performance criteria of this guide specification. A mutually acceptable third party (independent testing laboratory/service) may be used to conduct the required tests.

(2) A copy of the signed test report(s) shall be made part of the vehicle documentation package. These tests need not be repeated for follow-on production vehicles. However, if substantive changes in design are made or unusual options are requested, which could reasonably be expected to affect one or more of the required vehicle performance criteria, the applicable test shall be repeated.

(3) There shall be a tilt table side slope test of vehicles fitted with elevated boom type devices. The vehicle must meet the minimum side slope angle of the class vehicle, with the boom in the nested or bedded position. This test needs only be accomplished for the first test article vehicle or if significant relocation of weight distribution occurs due to other possible center

of gravity changes resulting from installation of specialized equipment such as generators

c. Vehicle Acceptance Tests.

(1) The tests listed in paragraph 12 1 shall be conducted by the ARFF vehicle manufacturer on every vehicle. These tests may be conducted at the manufacturer's facility, at the airport, or at another mutually acceptable test site.

(2) The results of these tests shall be recorded and signed by the test manager. A copy of the signed test report(s) shall be made part of the vehicle documentation package.

101. TECHNICAL SERVICE, PERFORMANCE DOCUMENTATION, AND TRAINING.

a. The vehicle documentation package shall include two copies each of an Operator's Manual, a Parts Manual, and the Maintenance/Service Manual applicable to the specific vehicle. It shall also include one signed copy of each of the certification(s) and test report(s) required by paragraphs 100.a, b, and c.

(1) The Operator's Manual shall include all information required for the safe and efficient operation of the automotive chassis, the fire extinguishing equipment, and any special attachments or auxiliary equipment. The location and function of all controls and instruments shall be illustrated and described. The manual shall at least:

(a) Cover preparation of the vehicle for service upon receipt from the manufacturer.

(b) Give a general description of, and step-by-step instructions for, the operation of the vehicle and its fire extinguishing system(s).

(c) Provide checklists for the daily maintenance inspections and mission readiness checks that the operator is expected to perform.

(d) Provide schedules for required preventative maintenance and required periodic maintenance.

(2) The Parts Manual shall include illustrations and exploded views, as needed, to properly identify all parts, assemblies, subassemblies, and special equipment. All components of assemblies shown in illustrations or exploded views shall be identified by reference numbers which correspond to the reference numbers in the parts lists. All purchased parts shall be cross-referenced with the original manufacturer's name and part number. The parts list shall indicate the quantity of each item used per vehicle. The manual shall contain an alphabetical and a numerical parts list in addition to a table of contents.

(3) The Maintenance/Service Manual, shall identify any special tools and test equipment required and shall cover troubleshooting and maintenance as well as minor and major repair procedures. The text shall contain performance specifications, tolerances, and fluid capacities; current, voltage, and resistance data; hydraulic, pneumatic, and electrical diagrams; and such other illustrations and exploded views as may be required to permit proper maintenance by qualified mechanics. The manual shall contain an alphabetical subject index as well as a table of contents.

(4) The Certification Documents and Test Reports shall be bound or otherwise packaged in a manner suitable for filing.

b. The manufacturer shall, at no additional cost, provide trained personnel at the time of delivery and provide adequate training as specified by the purchaser for firefighter and/or airport personnel in its operation and maintenance. Training shall include written operating instructions that depict the step by step operational use of the vehicle. Written instructions shall include, or be supplemented by, materials which can be used to train subsequent new operators.

Section 2. Certification of Performance.

103. COMPONENT MANUFACTURER'S CERTIFICATION. A copy of the component manufacturer's certification (signed application approval) shall be provided for each of the following ARFF vehicle components:

- a. Axles.
- b. Complimentary Agent Pressure Relief Device.
- c. Complimentary Agent Storage Container.

102. NAMEPLATES AND INSTRUCTION PLATES.

a. All nameplates and instruction plates shall be made of a material which, is not degraded by weathering or exposure to water, **firefighting** agents, vehicle operating fluids, or hydrocarbon fuels and solvents. The information may be engraved, stamped, or etched on the plate. All plates shall be attached with screws, bolts, or rivets as may be appropriate for the location. Each plate shall be mounted in a conspicuous place on or near the item it identifies or for which it gives instructions.

b. Nameplates shall show make, model, serial number, and other such data as may be appropriate for positive item identification.

c. Instruction plates shall provide specific directions to be followed for safe, efficient operation, or servicing the vehicle or equipment. These plates shall include specific warnings or **cautions** as may be necessary to protect operation and maintenance personnel from such hazards as high voltage, pressure and temperature, sharp **edges**, moving parts, or hazardous materials. These plates shall be so located and of **sufficient** size to be readily seen under normal operating and service conditions. Instruction plates essential to the safe and effective operation of the vehicle and fire suppression system(s) shall be illuminated for night operations. For example, there shall be a data plate visible to the driver that includes vehicle weights and dimensions and an inclinometer calibrated to indicate manufacturers safe **dynamic** side slope operation. Another data plate should list all fluid types and capacities for the intended use.

d. Engine(s); Prime Mover(s) and Pump, If Separate.

e. **Handline** Hose(s) with Couplings Attached.

f. Propellant Gas Cylinder(s).

g. Propellant Gas Cylinder Regulating Device.

h. **Tires.**

- i. Transfer Case.
- j. Transmission.
- k. Wheels.

104. VEHICLE MANUFACTURER'S CERTIFICATION. The vehicle manufacturer shall certify in writing that the following components or subsystems comply with the applicable requirements of this AC or a comparable, recognized standard:

Component:	Paragraph Number	Table 2 Item No.
a. Brake		
(1) Air Supply	32a(1) thru (5)	None
(2) Emergency	32b	11
(3) Parking	32c	12
(4) Service	32d(1) and (2)	10
b. Cooling System	44	None
c. Exhaust System	45	None
d. Fuel System	46	None

Section 3. Prototype Vehicle Performance.

105. PROTOTYPE TEST LIST. The tests listed below shall be conducted by the manufacturer, an agent of the manufacturer, or an independent agent or agency on the "first article" produced to meet the performance criteria of this guide specification or a comparable recognized standard. Should major modification such as a new suspension design, or major alteration such as installation of a high reach or extendible turret device be made to the vehicle, tests to **certify** compliance with Section 114, Stability: Dynamic and Static, must be repeated. The specific facilities, equipment, test conditions, test procedures, and the pass/fail criteria detailed in paragraphs 106 through 118 of this section shall be used for each function to be tested.

a. Brake Systems:

- (1) Grade Holding--Service and Parking
- (2) Stop Distance--Service and Emergency

b. Complimentary Agent Systems:

- (1) **Handline** Discharge Rate and Range
 - (a) Dry Chemical
 - (b) Halotron I or approved equivalent
- (2) Propellant Gas
- (3) Purge and Vent System

- (4) System Pressure Regulation
- c. Electrical Charging System**
- d. Flexibility of Body and Chassis**
- e. Foam/Water Agent System:**

(1) Bumper Turret/Ground Sweep Discharge Rate, Range, and Pattern

(2) Flush Capability

(3) **Handline** w/Nozzle Discharge Rate, Range, and Pattern

(4) Proportioning and Foam Quality

(5) Pump and Roll Capability

(6) Pump Total Discharge Capacity

(7) Roof Turret(s):

(a) **Azimuth** and Elevation Limits, Control, and Indicator

(b) Control System Resistance

(c) Discharge Rate, Range, and Pattern

(8) Tank(s):

(a) Fill--Overflow and Vent Capacity

(b) Minimum Rated Capacity

(9) Undertruck Nozzle Pattern

f. Gradability

g. Radio Interference Suppression

h. Siren Output: Direction and Magnitude

i. Stability:

(1) Dynamic/Turning Control

(2) Static/Side Slope Stability

j. Steering System:

(1) Resistance/Operating Force Requirements

(2) Wall-To-Wall Turning Diameter

k. Underbody Clearances

l. Visibility: Included Angles From Driver's Seat

m. Vehicle Interior Noise Levels

106. BRAKE SYSTEMS PERFORMANCE.

a. Facilities.

(1) Tests 1 and 2 require two ramps or inclines (man made or natural) known to be 20 percent and 50 percent grades.

(2) Tests 3 and 4 may be conducted on any paved surface that can support the vehicle weight and the resulting braking forces and is long enough to allow for the combined acceleration,, constant speed, and safe braking distance. The site shall be marked out in a lane that is the width of the vehicle to be tested, plus four feet (1.2 m).

(3) A runway or **taxiway** with a marked center line that meets the length, strength, and other conditions specified is an acceptable alternative test site.

b. Equipment.

(1) Tests 3 and 4 require a calibrated fifth wheel connected to a ground speed readout device which is accurate to ± 0.5 percent of the actual measured speed.

(2) Tests 3 and 4 require a brake triggered device which will mark the strip recorder to show initial brake application.

(3) Tests 3 and 4 require a strip recorder with sufficient resolution to record the vehicle speed, brake application point, and stop point with the same accuracy as that required for the **fifth** wheel.

NOTE: The use of other data collecting/recording devices of equal accuracy-and precision is acceptable.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package for the specific vehicle.

c. Test Conditions.

(1) The grades used for Tests 1 and 2 shall be **dry**, smooth, **free** of loose material, and long enough to accommodate the length and strong enough to hold the fully loaded vehicle.

(2) The vehicle shall be **fully** loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(3) The brakes shall be burnished and adjusted to the manufacturer's specifications.

(4) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

(5) The surface of the site for Test 3 and 4 shall be level, dry, smooth, and, free of any loose material.

d. Test Procedures.**(1) TEST-1. Grade Holding--Parking Brake.**

(a) Drive the vehicle in the **forward** direction up the 20 percent grade, stop the vehicle with using the service brake, and **set** the parking brake.

(b) Shift the transmission to neutral, release the service brake, and monitor the vehicle visually for 5 minutes for any perceptible wheel rotation. **Record** the results.

(c) Repeat steps (a) and (b) except that the vehicle shall be backed up the grade.

(2) TEST-2. Grade Holding--Service Brake.

(a) Drive the vehicle in the forward direction up the 50 **percent** grade and stop **the** vehicle with the service **brake**.

(b) Continue holding the vehicle with the service brake, shift the transmission into neutral, and monitor the vehicle visually for 5 minutes for any perceptible wheel rotation. Record the results.

(c) Repeat steps (a) and (b) except that the vehicle shall be backed up the grade.

(3) TEST-3. 'Stop Distance--Service Brake.

(a) Start the vehicle, turn on the strip recorder, accelerate to 20 mph (32 km/h), and maintain that speed for at least **50 feet** (15 m). ;

(b) Apply the service brake as if in a panic stop; hold the brake on until the vehicle, stops. Record the printout of the distance traveled **from** the initial braking until the vehicle came to a stop. No steering corrections shall be made for vehicle **drift** during the stop.

(c) **Measure** and record the perpendicular distance **from** the nearest lane edge line to the outer most edge of the vehicle's width. Report the measurement as a negative number if the vehicle is outside of the test lane; OR,

(d) If the test lane has a marked center line, measure and record the perpendicular distance

from the centerline to the outer most edge of the vehicle that **is, farthest from** the center line of the test lane.

(e) Repeat the steps (a) through (d) for two complete cycles in each direction of the test lane; record each braking distance for 20 mph (32 km/h).

(f) Repeat steps (a) through (e) above except that the test speed shall be 40 mph (64 km/h).

(4) TEST-4. Stop Distance--Emergency Brake. Repeat Test-3, steps (a) through (e) above for the emergency brake except that only the 40 mph **(64km/h)** test speed shall be used.

(5) TEST-5. Circuit Failure--Service Brake.

(a) Disable one dual brake circuit and repeat Test-3, steps (a) through (e) for the service brake at a speed of 40 mph (64 km/h).

(b) Reconnect the first circuit, disconnect the second, and repeat Test-3, steps (a) through (e) on the second service brake circuit at 40 mph (64 km/h).

e. Pass/Fail Criteria.

(1) The service and parking brake grade holding performance shall comply with the applicable portions of paragraph 32 and the applicable standards of table 2, Performance Parameters 10 and 12.

(2) For all stop tests conducted in a lane with 'outer boundary markers, **NO** portion of the vehicle shall be outside those boundaries after the vehicle stops.

(3) For all stop tests conducted in a lane with a marked centerline, the measured distance from the outer most portion of the vehicle to the centerline of the lane shall be less than one-half of the vehicle width, plus 2 feet (0.6 m).

(4) Each of the four recorded stop distances for the service and emergency brakes shall meet the applicable stopping distance standards of table 2, Performance Parameters **10** and 11.

(5) Each of the four recorded stop distances, for each circuit, for the split circuit service brake test shall meet the applicable stopping distance standards

of Table 2, Performance Parameters 11, Emergency Brake.

107. COMPLEMENTARY AGENT SYSTEM.

NOTE: If the vehicle manufacturer provides signed test data that verifies system performance, or a performance certificate from a third party for a complementary agent system of the same brand, general size, and flow rate, or similar documentation from the actual complementary agent system manufacturer, that documentation may be submitted as an additional item under the terms of paragraphs 100 and 103 and the test requirements of this paragraph (but not the pass fail/criteria) shall be waived.

a. Facilities for Agent System Test Series **Tests-1, 2, and 3** require a level, open site (free of obstructions within the expected agent range) that is suitable for the discharge of approximately 500 pounds (230 kg) of the complementary agent being tested.

b. Equipment for the Complimentary Agent System Test Series.

(1) Tests **1, 2, and 3** require a means of removing the agent tank from the vehicle without loss of agent and moving it to the weighing device.

NOTE: Alternatively, the system may be tested as a unit outside the vehicle providing that the agent tank, related piping, fittings, valves, hose and nozzle(s) are in the same configuration as they will be in when installed on the vehicle. OR, the system may be tested as an integral part of the completed prototype vehicle as long as the weighing device meets the requirements of paragraph **107.b.(2)**.

(2) A calibrated scale or load cell with an accuracy of ± 1 percent of the amount of agent to be weighed.

(3) A stopwatch which can be read to ± 0.5 seconds.

(4) A tape measure or other distance measuring device that can be read to ± 0.5 inches.

(5) An anemometer capable of reading wind velocities in the range of 0 to 10 mph (0 to 16 **km/h**) with ± 0.5 mph (0.8 km/h) accuracy.

(6) Test-4 requires a means of connecting a pressure gauge or transducer between the low pressure (downstream) side of the regulator and the agent tank inlet valve.

(7) Test-4 requires a calibrated pressure sensing device capable of reading pressure with an accuracy of ± 1 percent of the pressure to be measured.

(8) Test-4 requires a pressure reading device connected to the piping between the low pressure propellant gas inlet valve and the agent tank top. If the tank is equipped with a gauge having **sufficient** accuracy, it may be used.

(9) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions for Agent System Series.

(1) The complimentary agent tank pressure relief device shall have been certified as required in paragraph 103.b and shall be operational.

(2) The agent tank shall have been certified as required in paragraph **103.c** and shall be clean, dry, and empty.

(3) Propellant gas tanks shall have been certified as required in paragraph 103.f and shall be pressurized to the recommended operational pressure.

(4) Wind conditions shall be in the range of 0 to 5 mph (0 to 10 **km/h**).

(5) The vehicle (or alternative test unit) shall have all agent piping operational.

d. Test Procedures.

(1) **TEST-1. Handline** Discharge Rate and Range.

NOTE: This test may be combined with Test-4 if sufficient agent remains in the tank.

(a) Charge the agent tank using the manufacturer's recommended agent and **fill** procedure. Weigh it and record the gross filled weight.

(b) Reconnect the tank to the system and ensure that fill cap(s) are secure, propellant gas lines

are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(c) Pull all **handline** hose **from** the reel(s), position nozzles so that they may be discharged **onto the** test site with no stream obstructions and such that the stream patterns will not overlap. Pressurize the system using the manufacturers recommended procedure.

(d) Select one of the **handline** nozzles and hold it in a fixed, horizontal position between 36 and 60 inches (90 and 150 cm) above the ground level. Simultaneously start the stopwatch and fully open the nozzle.

(e) Monitor the time, and after approximately 20. seconds of discharge time has elapsed, simultaneously shut down the nozzle and stop the stopwatch.

(f) Measure the level. ground distance **from** the spot directly below the nozzle to the far edge of the discharge pattern. Record this distance. as the range for nozzle number one.

(g) Reweigh the dry chemical agent tank and record this weight as the discharge weight for nozzle number one.

(h) Reconnect the agent tank, pressurize the system, and if there is more than one dry chemical handline, repeat steps (d) through (g) for nozzle number **two**.

(i) After testing nozzle number two, reconnect the agent tank, pressurize the 'system, and repeat steps (d) through (g) while simultaneously discharging both **handline** nozzles.

(j) Calculate the nozzle discharge rates (DR), in pounds per second, as follows:

$$\text{Nozzle \#1: DR} = \frac{\text{Gross Filled Wt} - \text{Discharge Wt \#1}}{\text{Time (Seconds)}}$$

$$\text{Nozzle \#2: DR} = \frac{\text{Discharge Wt \#1} - \text{Discharge Wt \#2}}{\text{Time (Seconds)}}$$

$$\text{Dual Noz: DR} = \frac{\text{Discharge Wt \#2} - \text{Discharge Wt Dual}}{2 \times \text{Time (Seconds)}}$$

(2) TEST-2. Propellant Gas Quantity.

NOTE: May be combined with Test-3.

(a) Weigh the empty agent tank(s) and record the tare weight.

(b) Charge the agent tank using the manufacturer's recommended agent and till procedure. Weigh the tank and record it as the "gross filled weight."

(c) Reconnect the tank to the system and ensure that fill cap(s) are secure, propellant gas lines are connected, discharge nozzles are in the closed position and that all fittings and connections are tight.

(d) Pull all **handline** hose **from** the reel(s) and position nozzles so that they may be discharged onto the test site with no stream obstructions. " Pressurize **the** system using the manufacturer's recommended procedure.

(e) Simultaneously open all discharge nozzles **fully** and continue agent discharge **until** only the pressurizing gas is discharged. Shut down the propellant gas supply.

(f) Reweigh the agent tank and record as the post discharge weight.

(g) Calculate the amount of agent remaining and report the results as follows:

$$\begin{aligned} \% \text{ Agent Remaining} &= \frac{\text{Post Discharge Wt.} - \text{Tare Weight}}{\text{Gross Filled Wt.} - \text{Tare Weight}} \times 100 \end{aligned}$$

(3) TEST-3. System Pressure Regulation

NOTE: May be combined with Test-2.

(a) Charge the agent tank using the manufacturer's recommended agent and fill procedure.

(b) Reconnect the tank to the system and ensure that fill cap(s) are secure, propellant gas lines are connected, discharge nozzles are in the closed position and that all fittings and connections are tight.

(c) Pull all **handline** hose **from** the reel(s) and position nozzles so that they may be

discharged onto the test site with no stream obstructions. Pressurize the system to the manufacturer's recommended operating pressure using the manufacturer's recommended procedure and record the agent tank operating pressure.

(d) Simultaneously open fully all discharge nozzles. Continue agent discharge and monitor and record agent tank pressure at **5-second** intervals until only the pressurizing gas is discharged. As soon as only propellant gas is being discharged at all nozzles, shut down the propellant gas supply.

(4) **TEST-4. Purge and Vent System.**

NOTE: May be combined with Test- 1.

(a) Charge the agent tank using the manufacturer's recommended agent and fill procedure.

(b) Reconnect the tank to the system and ensure that fill cap(s) are secure, propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(c) Pull all **handline** hose **from** the reel(s) and position nozzles so that **they** may be discharged onto the test site with no stream obstructions. Pressurize the system to the manufacturer's recommended operating pressure using the manufacturer's recommended procedure and record the agent tank operating pressure.

(d) Simultaneously open fully all discharge nozzles. Continue agent' discharge for approximately 10 seconds and then shut down all nozzles.

(e) Purge all discharge lines and nozzles using the manufacturer's recommended procedure.

(f) Vent the agent tank using the manufacturer's recommended procedure.

e. Pass/Fail Criteria.

(1) The discharge rate **from** each nozzle shall fall within the standard range specified in table 3, Performance Parameter **1.a** or **2.a**, and shall be within ± 10 percent of each other.

(2) The range **from** each nozzle shall meet or exceed the standard specified in table 3, Performance Parameter 1 .b or 2.b.

(3) When discharged simultaneously, the averaged discharge rate from either nozzle shall be within ± 10 percent of either nozzle discharging alone.

(4) There shall be sufficient propellant gas remaining after agent discharge stops to purge all agent lines clear of agent **from** the tank through, and including, the hose line(s) and nozzle(s).

(5) The amount of agent remaining in the tank(s) after agent discharge stops shall not exceed **five** percent of the initial quantity.

(6) The performance of the pressure regulating device shall be acceptable if it is **capable of** maintaining the tank pressure within the manufacturer's recommended operating pressure range throughout the entire discharge time.

(7) At the end of the purge process (for a dry chemical system), loose agent shall not be left laying in the horizontal piping beyond the agent tank valve,

(8) The **depressurization/venting** process shall allow only minimal quantities, i.e., one pound (0.5 kg) or less, of the agent to escape from the agent tank.

(9) The venting process shall NOT allow any agent to enter the discharge piping, handlines or nozzles.

108. **ELECTRICAL CHARGING SYSTEM.**

a. **Facilities.** This test requires an area suitable for running the engine(s) while the electrical loads are operating and the charging current and voltages are being measured.

b. **Equipment Required.**

(1) The vehicle tachometer as installed.

(2) A voltmeter with a range, compatible with the design voltage of the vehicle electrical system, that can be read with an accuracy off 0.1 volt.

(3) Two ammeters, with a range compatible with the current load, that can be read within ± 1 percent of the actual current flow.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The batteries shall be fully charged, i.e., the specific gravity of each battery shall be at the manufacturer's specifications.

(2) The vehicle electrical system and charging device shall be **fully** operational.

(3) The ambient temperature shall be within the range of **50° to 90° F** (10° to 32° C).

(4) The voltmeter shall be installed to continuously measure the battery voltage.

(5) An ammeter shall be installed in a manner that will permit reading of the current flow from the battery to the electrical devices.

(6) A second ammeter shall be installed in a manner that will permit reading the maximum current flow from the alternator to the rest of the electrical system, excluding the starter.

(7) Start the engine and allow it to run, with all electrical devices turned off, long enough to recharge the batteries prior to beginning the test.

d. Test Procedure. Voltage and current flow readings shall be recorded for the following conditions:

(1) Engine at idle with:

(a) Battery alone.

(b) All electrical devices normally expected to be operating simultaneously turned on.

(2) Engine at 50 percent governed speed with all electrical devices normally expected to be operating simultaneously turned on.

(3) Engine at maximum governed speed with all electrical devices normally expected to be operating simultaneously turned on.

e. **Pass/Fail Criteria.** The electrical system performance shall be acceptable if it meets or exceeds the following:

(1) Engine at idle with:

(a) Battery alone.

(i). Voltage at battery shall remain above 13 volts.

(ii) Current output shall equal the battery manufacturer's recommended charging rate, if less than 50 amps, or be at least 50 amps while battery is charging.

(b) All electrical devices normally expected to be operating simultaneously turned on.

(i) Voltage at battery shall remain above 13 volts.

(ii) Current output shall be at least 50 amps or shall be equal to the sum of the current demand of the operating electrical devices if that current demand is lower than **50** amps.

(2) Engine at 50 percent governed speed with all electrical devices normally expected to be operating simultaneously turned on.

(a) Voltage at battery shall remain above 13 volts.

(b) Current output shall be equal to the sum of the current demand of the operating electrical devices.

(3) Engine at maximum governed speed with all electrical devices normally expected to be operating simultaneously turned on.

(a) Voltage at battery shall remain above 13 volts.

(b) Current output shall be equal to the sum of the current demand of the operating electrical devices.

109. BODY AND CHASSIS FLEXIBILITY.

a. Facilities. This test requires a flat area suitable for discharging agent and driving the vehicle onto portable ramps.

b. Equipment Required.

(1) Two to four double-ended ramps with a flat top long enough for the whole tire foot print. The approach and departure slopes of the ramps shall be graded to allow the vehicle to ascend and descend safely. The height of the ramps shall be 14 inches.

(2) A test report notebook or similar **record** form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be tested in its fully loaded condition. Ballast shall be used to simulate equipment and crew weights as needed. If used it shall be distributed realistically, i.e., an artificial center of gravity is not permitted.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.**(1) TEST-1. 4 X 4 Vehicles.**

(a) Drive the vehicle onto two ramps positioned to raise the diagonally opposite front and rear wheels.

(b) Inspect the vehicle for any visible signs of clearance between the tires and the ground or supporting ramp surfaces, for component interference, sheet metal buckling, and for interference with moving parts, including doors and equipment compartment closures. Record the results.

(c) Demonstrate the operation of all electrical, pneumatic, hydraulic and agent systems, including the discharge of agent **from** all orifices. Record the results.

(d) Drive the vehicle off the ramps and reposition them to raise the other two diagonally opposite front and rear wheels.

(e) Repeat steps (b) and (c) above.

(f) Review the test record for any misfits or malfunctions, make any necessary repairs, and repeat the test as necessary.

(2) TEST-2. 6 X 6 Vehicles.

(a) Drive the vehicle onto **two** ramps positioned to raise a **front** wheel and the diagonally opposite rear wheel on axle number three.

(b) Repeat steps (b) and (c) in Test-j above.

(c) Drive the vehicle off the ramps, position a third ramp so that **the second** rear wheel on the same side will also be elevated and repeat steps (b) and (c) in Test-l above.

(d) Reposition **the** vehicle/ramps so as to raise the other set of wheels and repeat steps (a) through (c) above.

(e) Review the test record for any misfits or malfunctions, make any necessary repairs, and repeat the test as necessary.

(3) TEST-3. 8 X 8 Vehicles.

(a) Drive the vehicle onto two ramps positioned to raise the **front** wheel on axle number one and the diagonally opposite rear wheel on axle number four.

(b) Repeat steps (b) and (c) in Test-l above.

(c) Drive the vehicle off the ramps, position two additional ramps so that the second front and rear wheels on the same side will also be elevated, and repeat steps (b) and (c) in Test-l above.

(d) Reposition the vehicle and ramps so as to raise the other set of wheels and repeat test.

(e) **Review** the test record for any misfits or malfunctions, make any necessary repairs, and repeat the test as necessary.

e. Pass/Fail Criteria.

(1) There shall be no interference between one moving part and any other or, between any moving part and an adjacent surface, structural member, or mounting device.

(2) All doors, equipment compartment closures, and hose reels shall function normally.

(3) There shall be no loss of performance in any operating subsystem.

(4) If there is any contact introduced by the twisting motion of the vehicle frame between major components, e.g., cab, agent tanks, engine compartment(s); engines, pumps, hose reels and the respective compartment walls and mounting fixtures, etc., that contact shall not damage or exhibit the potential to damage either component during the repeated flexing which is expected in normal service.

(5) There shall be no visible signs of clearance between any vehicle tire and the ground or ramp surfaces.

110. FOAM/WATERAGENTS SYSTEM.**a. Facilities.**

(1) A number of tests in this series requires a paved open area suitable for discharging large volumes of foam/water solution at high pressure. In Test-14, the area must have sufficient strength and size to accommodate the maneuvering of a fully loaded vehicle safely at speeds up to 25 mph (40 km/h). In Test-1, the area must include measured grades of 20 and 30 percent.

(2) An off-road area with similar characteristics to accommodate the maneuvering of a fully loaded vehicle safely at speeds up to 10 mph (16 km/h) is also required for Test- 15.

(3) In addition, a site suitable for discharging agent which includes a certified grade of 40 percent that is at least twice the length of the vehicle being tested is required for Test- 16. If the alternate draw bar method is used, **Test-16A** requires a level, paved test pad adequate for an extended draw bar pull that is also suitable for the discharge of large volumes of agent at high pressure.

(4) All tests require a water supply sufficient to refill vehicle tank(s) as needed.

(5) Test-1 requires a means of delivering water to the tank inlet at 80 psi (5.5 Bar) and in sufficient volume to permit the filling of the tank of the appropriate vehicle class in 2 minutes or less.

b. Equipment required.

(1) As required to perform specific tests in this series in accordance with NFPA 412, "Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles."

(2) Vehicle/pump engine(s) speedometer, tachometer, and agent system discharge pressure gauge as installed by the manufacturer.

(3) A stopwatch that can be read to ± 0.5 seconds.

(4) A supply of foam concentrate sufficient to refill vehicle foam tank(s) as needed.

(5) Test-1 requires two water pressure measuring devices with an accuracy off 1 percent of the pressure being measured: calibrated sight gauges and a liquid volume measuring device with an accuracy off 1 percent of the volume being measured.

(6) Tests-3, -4, -14, -15, -16, and **-16A** require a supply of an approved water soluble dye.

(7) If one of the optional flow rate methods described in **Tests-5A, -7A, or -11A** is used, a calibrated sight gauge, a calibrated, open top receiver of sufficient capacity to collect at least 25 percent of the water tank volume, or appropriate flow meters capable of being read to ± 1 percent of the liquid volume to be measured, will be needed.

(8) Tests-9, -10, and -11 require a tape measure capable of measuring 30 feet (9 m) with an accuracy of ± 0.5 inches (1.25 cm), a 3-foot (1 m) carpenter level, a large protractor with an accuracy of ± 1 degree, and a spring scale or other suitable torque measuring device that can be attached to the turret or turret control handle and has an accuracy of ± 1 percent of the quantity being measured.

(9) Test-13 requires a means of marking or defining the vehicle plan view on the ground and for

marking the undertruck nozzle discharge pattern on the **plan** view outline.

(10) If the alternate draw bar pull method is used in **Test-16A**, a load cell, accurate to within ± 500 lbs. (230 kg) and a variable load dynamometer sled, are required.

(11) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) Verify and record the fact that the agent system pressure relief valve has been set to the recommended relief pressure and is functioning prior to the beginning of any test in this series.

(2) To ensure test operator safety and to validate the effectiveness of subsystem integration, this series of tests shall be performed and passed in the order presented.

EXCEPTION: Tests-14 and -17 may be combined

(3) The temperature of the water and the foam concentrate shall be within the foam manufacturer's recommended operating temperature range.

(4) The water and the foam tanks shall be full at the start and shall be refilled as needed to complete the tests.

(5) The foam concentrate proportioners shall be set at the appropriate rate for the foam concentrate to be used at the airport.

(6) The agent selector shall be set for foam/water discharge.

(7) The vehicle shall be fully loaded with the tires inflated to the manufacturer's recommended operating pressure. Appropriate ballast may be used as needed to account for the crew and equipment allowances.

(8) The engine(s) and transmission shall be at a normal operating temperature;

(9) Handlines shall be fully deployed and the nozzles shall be set for straight stream during discharge rate tests.

(10) The agent pump, fill system, overflow/vent system, water and foam discharge system, foam proportioning system, and primary turret(s) shall be fully operational during these tests.

d. Test procedures.

(1) **TEST-1. Fill, Overflow, and Vent.**

(a) At the beginning of this test, the vehicle shall be parked on level ground, the water tank fill and vent system shall be **fully** operational, the water tank(s) shall be empty, and pressure measuring devices shall be attached to the vehicle in such a manner that the internal tank pressure and the tank inlet pressure can be monitored during the tank tilling process.

(b) The water supply pressure at the tank inlet shall be maintained at 80 psi (5.5 Bar) ± 5 percent throughout the filling and overflow process.

(c) Simultaneously initiate flow to the tank and start the stopwatch. Stop and record the time at the first flow of water from the overflow vent.

(d) Continue the flow of water while maintaining -80 psi (5.5 Bar) at the tank inlet and continue to monitor the tank pressure for an additional 30 seconds (approximately). Shut off the water and record the highest pressure reached during the overflow period.

(2) **TEST-2. Minimum Rated Capacity.**

(a) With the vehicle parked on level ground and sight gauges attached to both the water and foam concentrate tanks, fill the inlet piping until the water reaches the bottom of the **tanks**. Do NOT record the volume of water used. Add an appropriate quantity of an approved water soluble dye to the foam concentrate tank.

(b) The tank(s) shall be filled using a liquid volume measuring device. At approximately every 2 percent of the tank capacity for the bottom 25 percent and every 10 percent of the remaining tank capacity, the volume added shall be correlated with the sight gauge(s) calibrations. If necessary, a correction table or graph shall be prepared for each sight gauge

on each **tank**. When the tanks are filled to the top, the total volume of water added to each tank shall be recorded as: "Water Tank Full" or "WTF" and "Foam Concentrate Tank Full" or "FCTF."

(c) With the agent system set to discharge foam and tanks completely full, discharge shall be initiated and continued at the maximum turret discharge setting. **At the first** indication of a discharge pressure drop (pump cavitation), agent discharge shall be stopped. **Dye** shall be visible in the discharge stream throughout the test.

(d) The volume of water remaining in each tank shall be measured and recorded as: "Water Tank Empty" or "WTE" and "Foam Concentrate Tank Empty" or "FCTE."

(e) The difference between the volume of the liquid in the water tank recorded in steps (b) and (d) shall be calculated and recorded as the volume of water discharged from that tank on level ground, i.e., "Rated Water Tank Capacity--Level."

(f) **ONLY** the water tank shall be refilled and steps (c) through (e) shall be repeated until all usable liquid has been discharged from the foam concentrate tank. The volume of water remaining in the foam concentrate tank shall be measured and recorded as "FTC-LX," where X represents the number of loads of water used to deplete the foam tank volume.

(g) The difference between the initial volume (FCTF) recorded in step (b) and the "empty" volume (FCT-LX) from step (f) shall be calculated and recorded as the volume of "foam" discharged from that tank on level ground, i.e., the "Rated Foam Tank Capacity--Level."

(h) Refill both tanks and repeat steps (c) through (g) and record "Rated Water/Foam Tank Capacities" with the vehicle positioned as follows:

- (i) 20 percent side slope, **left** side up slope.
- (ii) 20 percent side slope, right side up slope.
- (iii) 30 percent ascending grade.
- (iv) 30 percent descending grade.

(3) **TEST-3, Flush Capability.**

(a) Fill the water and foam concentrate tanks with water and add a suitable amount of an approved water soluble dye to the foam tank.

(b) While operating in the foam mode, discharge agent through each water/foam discharge orifice until dye is detected. After dye is seen in the discharge stream of all orifices, shut off the discharge and record the dyed water volume remaining in the foam concentrate tank.

(c) Change the agent system settings to the flush mode and discharge water through each water/foam discharge orifice. As soon as the water runs clear from all orifices, shut off the discharge, record the dyed water volume remaining in the foam concentrate tank, and drain the piping.

(4) **TEST-4, Pump Total Discharge Capacity.**

NOTE: If the **vehicle** is equipped with multiple pumps, they shall be operated in parallel during this test.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator **outlets** closed. Observe and record pump pressure.

(c) Adjust roof turret elevation to optimum range position, open roof turret discharge valve, observe range of turret stream, continue flow to allow system pressure to stabilize, and observe and record discharge pressure.

(d) Continue turret discharge and initiate discharge from each **of the** following in its turn: the ground sweep or bumper turret, primary handlines (add one at a time), and undertruck nozzles. **All** applicators shall be discharging simultaneously in straight stream.

NOTE: As each additional applicator is turned on, the range of the initial turret stream and the initial range of each added appliance stream should be compared by observation. Observe system pressure and, after system pressure stabilization, record the pressure.

(e) Continue discharging with all applicators flowing until the system pressure has stabilized. Record the pressure and stop the test.

(5) TEST-5. Bumper Turret or Ground Sweep Discharge Rate.

NOTE: If the vehicle is equipped with multiple pumps, they should be operated in parallel during this test.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(c) Open discharge valve to full flow position and start stopwatch.

(d) Continue discharge and observe the discharge pressure gauge. At the first sign of pump cavitation (indicated by a significant drop in discharge pressure), stop the stopwatch and disengage the water pump. Record the time.

(e) Calculate the discharge rate (DR) in gallons per minute, as follows:

$$DR = \frac{\text{Minimum Rated Tank Capacity (Unit Vol.)}}{\text{Discharge Time (min.)}}$$

(6) TEST-5A. Optional Procedures: Sight gauge or flow meter.

(a) Steps (a) and (b) of Test-5 apply.

(b) Open discharge valve to the full flow position, monitor the discharge pressure gauge and, after pressure stabilizes, simultaneously read the initial tank volume (ITV) on the sight gauge and start the stop watch. After at least 1 minute of discharge, simultaneously read the remaining tank volume (RTV) and stop the watch. If a flow meter is used, read and record the flow rates at 15 second intervals during at least 1 minute of discharge.

(c) Report the average of the flow meter readings, or calculate and report the DR from the sight gauge results as follows:

$$DR = \frac{\text{Initial Tank Vol.} - \text{Remaining Tank Vol.}}{\text{Discharge Time (min.)}}$$

(7) TEST-6. Bumper Turret or Ground Sweep Range and Pattern.

NOTE: This test may be combined with Test-17.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(c) The test measurements for range and pattern of the foam/water solution discharge shall be conducted as described in NFPA 412.

(8) TEST-7. Handline Nozzle Discharge Rate.

NOTE: If the vehicle is equipped with multiple pumps, they shall be operated in parallel during this test.

(a) Adjust handline nozzle(s) pattern(s) to straight stream position. If the nozzle is nonaspirated, repeat this test or one of the optional tests with the nozzle pattern setting in the fully dispersed position.

(b) The vehicle engine(s) shall be started.

(c) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(d) Open handline nozzle control valve to full flow position and start stopwatch.

(e) Continue discharge and observe the discharge pressure gauge. At the first sign of a significant drop in discharge pressure, stop the watch and disengage the water pump. Record the time.

(f) Calculate the DR as follows:

$$DR = \frac{\text{Minimum Rated Tank Capacity (Unit Vol.)}}{\text{Discharge Time (min.)}}$$

(g) Service the vehicle and repeat steps (a) through (f) for each handline.

(9) TEST-7A. Optional Procedures: Using sight gauge, calibrated open top receiving tank, or flow meter, repeat steps (a) through (c) of Test-7.

(a) Sight Gauge. Open discharge valve to full flow position, monitor discharge pressure gauge and after pressure stabilizes, simultaneously read ITV on sight gauge, and start the stopwatch. After approximately 50 percent of the remaining water has been **discharged**, simultaneously read the RTV and stop the watch. Report the discharge rate based on the sight gauge results calculated as follows:

$$DR = \frac{\text{Initial Tank Vol.} - \text{Remaining Tank Vol.}}{\text{Discharge Time (min.)}}$$

OR,

(b) Flow Meter. Open discharge valve to **full** flow position, monitor discharge pressure gauge, and **after** pressure stabilizes, read and record flow rates at **15-second** intervals during discharge of at least 50 percent of the minimum rated tank capacity. Report the discharge rate based on the averaged flow meter readings. **OR,**

(c) Calibrated Receiver. **Open** discharge valve to full flow position, monitor discharge pressure gauge, and after pressure stabilizes, simultaneously direct the **handline** discharge stream into the open top of the calibrated receiver and start the stopwatch. When the receiver is full, stop the stopwatch and shut down the stream. Repeat the process three times, calculate the results as shown below, and report the average.

$$DR = \frac{\text{Calibrated Receiver Tank Volume}}{\text{Discharge Time (min.)}}$$

(10) Handline Nozzle Discharge Range and Pattern.

NOTE: This test may be combined with Test-17.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(c) The test measurements for range and pattern of the foam/water solution discharge shall be conducted as described in NFPA 4 12.

(11) TEST-9. Turret(s) Azimuth and Elevation Limits.

NOTE: If provided, the turret 'power assist system shall be fully operational during this test.

(a) The turret shall be pointed parallel to the vehicle length and elevated to the maximum vertical travel. The angle formed by a horizontal, level line through the vertical rotation axis and the turret barrel centerline shall be measured and recorded.

(b) The turret shall be rotated to its maximum horizontal travel (both left and right of the straight ahead position) when the turret is:

(i) At maximum vertical depression.

(ii) At maximum elevation.

(iii) In the horizontal position.

The angle of turret rotation, left and right of center, for each of these configurations shall be measured and recorded.

(c) Markers or a line shall be placed perpendicular to the vehicle centerline and 30 feet (9 m) in front of the forward edge of the **front** bumper. The turret shall be:

(i) Aimed parallel to the vehicle centerline.

(ii) Lowered to its maximum vertical depression.

(iii) Set for maximum dispersed pattern.

(iv) Set to operate at maximum design flow rate.

With the turret at these settings, the agent system shall be activated and water shall be discharged. The point of impact relative to the line or markers shall be noted and recorded and the actual distance measured and recorded.

(12) TEST-10. Roof Turret Control System Resistance.

NOTE: If provided, the turret power assist shall be fully operational and used during the control force measurements.

(a) A suitable spring scale, or other torque measuring device shall be attached to the turret in such a manner that the forces at the turret control handle can be measured.

(b) The turret discharge shall be set for a straight stream at maximum flow rate. Measure and record the force required to:

(i) Start turret movement from center to the left and to the right.

(ii) Continue the turret movement, after start **from** center, to the left and right stops.

(iii) Start turret movement from the full **left** and right stops.

(iv) Continue the turret movement, after start **from** both the left and right stops, to the opposite stop.

(v) Start turret movement **from** horizontal to the elevated and the depressed positions.

(vi) Continue the turret movement, after start **from** the horizontal, to **both** the elevated and the depressed stops.

(vii) Start the turret movement **from** **both** the elevated and depressed stops.

(viii) Continue the turret movement, after start from both the elevated and depressed stops to the opposite stop.

(c) The turret discharge shall be changed to maximum flow With dispersed pattern and steps (b)(i) through (viii) shall be repeated.

(13) TEST-11. Turret Discharge Rate.

NOTE: If the vehicle is equipped with multiple pumps, they should be operated in parallel during this test.

(a) Adjust the turret to full flow, straight stream pattern and elevate to optimum range position.

(b) The vehicle engine(s) shall be started.

(c) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(d) **Open** turret discharge valve to **full** flow position and start the stopwatch.

(e) Continue discharge and observe the discharge pressure gauge. At the first sign of a significant drop in discharge pressure, stop the watch and disengage the water pump. Record the time.

(f) Calculate the DR as follows:

$$D R = \frac{\text{Minimum Rated Tank Capacity (Unit Vol.)}}{\text{Discharge Time (min.)}}$$

(g) The turret pattern adjustment shall be changed to the fully dispersed pattern. Retain the full flow discharge and elevation/optimum range setting. Repeat (b) through (g).

(h) If applicable, change the turret flow rate to half flow and repeat steps (a) through (g).

(14) TEST-11A. Optional Procedures: Sight Gauge or Flow Meter.

(a) Follow steps (a) through (c) in Test - 11.

(b) **Sight Gauge.** Open discharge valve to full **flow** position, monitor discharge pressure gauge, and after pressure stabilizes, simultaneously read **ITV** on sight gauge and start the stopwatch. After approximately 50 percent of **the** remaining water has been discharged, simultaneously read the **RTV** and stop the stopwatch. Report the DR based on, sight gauge results calculated as follows:

$$D R = \frac{\text{Initial Tank Vol.} - \text{Remaining Tank Vol.}}{\text{Discharge Time (min.)}}$$

O R ,

(c) **Flow Meter.** Open discharge valve to **full** flow position, monitor discharge pressure gauge,

and after pressure stabilizes, read and record flow rates at 15 second intervals during discharge of at least 50 percent of the minimum rated tank capacity. Report the discharge rate based on the averaged flow meter readings.

(d) The turret pattern shall be changed to the fully dispersed pattern. Retain the full flow discharge and elevation/optimum range setting. Repeat (a) and (b) or (a) and (c).

(e) If applicable, change the turret flow rate to half flow and repeat steps (a) and (b) or (a) and (c).

(15) TEST-12. Turret Range and Pattern.

NOTE: This test may be combined with Test-17.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(c) The test measurements for range and pattern of the turret(s) foam/water solution discharge shall be conducted as described in NFPA 412.

(16) TEST-13. Undertruck Nozzle Pattern.

NOTE: The agent discharge system shall be fully **operational** during this test.

(a) The agent system shall be set to operate in the foam mode, and the agent pumps shall be engaged with all discharge orifices closed.

(b) As soon as the discharge pressure stabilizes, the undertruck nozzles shall be set to discharge simultaneously and continuously until there is a clearly defined pattern of foam under the vehicle.

(c) The discharge shall be stopped and the boundaries of the pattern marked, measured, and recorded.

(17) TEST-14. Pump and Roll Capability--Paved Surface.

NOTE: This test may be combined with Test-15.

(a) While operating the vehicle on a paved surface at a speed of approximately 20 mph (30 km/h), the agent system pump(s) shall be engaged and disengaged for at least three cycles. Any irregular vehicle or pump performance **shall be** recorded.

(b) The vehicle shall be slowed to approximately 5 mph (8 km/h), the primary turret(s) and ground sweep or bumper turret shall be prepared to discharge, and agent discharge shall be initiated through the primary turret(s) and the ground sweep/bumper turret.

(c) The vehicle shall be maneuvered forward and backward while discharging and operating at various speeds up to 5 mph (8 km/h). The agent pump(s) shall also be disengaged and engaged for at least three cycles while maneuvering at these speeds. While continuing to maneuver and discharge agent, observe the agent discharge pressure gauge for fluctuations until the water tank is empty. Record agent discharge pressures at 15-second intervals and note any irregular pump performance.

(18) TEST-15 Pump and Roll--Off-Road.

The vehicle shall be serviced and moved to a suitable off-road test site. Repeat steps (b) and (c) of Test-14 above.

(19) TEST-16. Pump and Roll--On Grade.

The vehicle shall be serviced and moved to a 40 percent grade site.

(a) The vehicle shall be positioned at the bottom of the grade and discharge initiated through the main turret(s) at full rated discharge. Record the stabilized discharge pressure.

(b) Immediately upon stabilization of the discharge pressure, initiate ascent of the grade and achieve a speed of at least 1 mph (1.6 km/h).

(c) During the ascent, the vehicle shall be brought to a stop and then resume its ascent; regaining a speed of at least 1 mph (1.6 km/h) before ending the test. Record the actual speed achieved and any changes in discharge pressure.

(20) TEST-16A. Pump-and-Roll--Alternate To Test On Grade.

NOTE: If an actual 40 percent grade is not available, the vehicle may be coupled to a "40 percent grade equivalent" draw bar load.

(a) The load cell reading (in unit force per square unit area) required to simulate the 40 percent grade must equal: $(\sin 21.8^\circ) \times (\text{gross vehicle weight})$ divided by the (square unit area of the load cell).

(b) With the vehicle coupled to the appropriate simulated grade/load, the test shall be conducted as described in Test- 16 above.

(21) TEST-17. Proportioning and Foam Quality.

NOTE: This test may be combined with Tests-6, -8, and/or -12.

(a) The vehicle engine(s) shall be started.

(b) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed;

(c) The foam/water solution discharged from each of the applicators listed below shall be tested for foam concentration, expansion ratio, and 25 percent drain time as described in NFPA 412. The foam concentrate delivered by each of the following applicators (while discharging individually and while discharging during combined simultaneous discharge) shall be determined and reported:

- (i) Roof turret **at full** discharge.
- (ii) Roof turret at one-half discharge.
- (iii) Ground sweep or bumper turret.
- (iv) **Handline(s)** with nozzles provided with truck.
- (v) Undertruck nozzles.

e. Pass/Fail Criteria.

(1) The performance of the water tank inlet system shall be acceptable if the total **fill** time, when using **an** inlet water supply with a constant pressure of

80 psi (5.5 Bar) at the tank inlet, is no more than 2 minutes.

(2) The tank vent system shall be acceptable if the internal tank pressure does not exceed the tank manufacturer's recommended operating pressure at any time during the fill or overflow test.

(3) The foam concentrate tank shall be acceptable if it meets or exceeds the requirements of paragraph 77.

(4) The water tank and the usable capacity shall be acceptable if it meets or exceeds the requirements of paragraph 80, and the minimum rated capacity conforms to table 3, **Performance** Parameters 7.a, b, and c, as applicable, to the vehicle class.

(5) The flush system shall NOT be acceptable if any discharge outlet fails to discharge clear water. The system shall be redesigned or repaired, as appropriate, and the test repeated until all discharge orifices discharge clear water.

(6) There shall be no increase (evidence of water tank feedback) or decrease (evidence of foam concentrate leakage) in the volume of the dyed water in the foam concentrate tank during flushing. If there is any volume change, the system shall be redesigned or repaired, as appropriate, and the test repeated until the system can be flushed without a gain or loss of liquid in the foam concentrate tank.

(7) The discharge range(s) shall show no signs of deterioration as additional applicators are engaged.

(8) The stabilized system discharge pressure shall not fluctuate by more than **10** percent when comparing the stabilized discharge pressure of the roof turret flowing by itself to the stabilized discharge pressure of the system with all appliances discharging simultaneously.

(9) Dye shall be evident in the stream discharging from all appliances at all times during the test.

(10) **The** ground sweep/bumper turret discharge rate shall be acceptable if it meets the criteria given in paragraph 83 and table 3, Performance Parameter 6.a or **7.a**, as applicable.

(11) The ground sweep/bumper turret discharge range and pattern shall be acceptable if they meet the criteria given in paragraph 83 and table 3, Performance Parameter 6.b.(1) and (2) or 7.b.(1)-(3) and 7.c, as applicable.

(12) The **handline** discharge rate shall be acceptable if it meets the criteria of paragraph 81 and the standards of table 3, Performance Parameter 3.a or 4.a, as applicable.

(13) The **handline** discharge range and pattern shall be acceptable if they meet the criteria given in paragraph 81 and the standards of table 3, Performance Parameter 3.b and c or 4.b and c, as applicable.

NOTE: **Handline** discharge performance criteria are based on testing with **the specified** minimum length of hose, i.e., 100 feet of hard rubber/reeled hose or 150 feet of woven jacket hose. If additional lengths are requested, the minimum nozzle discharge rates must still be met. Hence, it is understood that higher discharge pressure at the hose, inlet or larger diameter hose or both may be needed to meet the minimum nozzle discharge rate.

(14) The turret travel is acceptable if the horizontal and vertical travel angles and the turret stream near point of impact meet or exceed the criteria of paragraph 84.a and b(1) through (3).

(15) The forces required to operate the turret shall be acceptable if they are equal to or less than those specified by paragraph 84.c or d, as applicable.

(16) The turret discharge rate shall be acceptable if it meets or exceeds the criteria given in paragraph 84.e and the standards of table 3, Performance Parameter 5.a, as applicable to the vehicle class.

(17) The turret discharge range and pattern shall be acceptable if they meet or exceed the criteria given in paragraph 84 and the standards of table 3, Performance Parameter 5.b.(1) and (2), as applicable to the vehicle class.

(18) The undertruck nozzle discharge performance shall be acceptable if it conforms to the requirements of paragraph 85.

(19) There shall be no evidence of proportioning error, pressure surge/drops, or flow rate instability during the pump-and-roll tests.

(20) The operation of the pump shall not cause the engine to stall under any of the pump-and-roll test conditions.

(21) There shall be no evidence of unsafe vehicle dynamics, (e.g., lurching, sudden speed changes, sudden forward/backward motion or stops) resulting from the engagement/disengagement of the pumps during the pump and roll maneuvering or while the vehicle is stationary.

(22) There shall be no unsafe vehicle dynamics resulting from the engaging/disengaging of the vehicle drive.

(23) Foam solution or dye shall be evident in the discharge from all outlets operated during the pump and roll maneuvers.

(24) The foam concentrate proportioner system shall be acceptable if the foam solution concentration measured for each agent applicator, during individual and combined discharge, is within the applicable standard tolerance range specified in paragraph 76.

(25) The foam generation capability of the foam/water agent system shall be acceptable if the expansion ratio and 25 percent drainage time of the finished foam meet or exceed the criteria of paragraph 87.b and d, and the applicable standards of table 3, when measured for each agent applicator during individual and combined discharge.

111. GRADABILITY.

a. Facilities.

(1) This test requires a site with a known grade of at least 50 percent that is long enough to allow the vehicle being tested to achieve a speed of 1 mph (1.6 km/h) with all wheels still on the grade.

(2) If the optional simulated grade/draw bar pull method is used, a level, paved site is required that can accommodate the combined length of the vehicle being tested and a load dynamometer sled while this combination achieves speeds up to 1 mph (1.6 km/h).

b. Equipment Required.

(1) If the alternate draw bar pull method is to be used, a load cell accurate to within ± 500 lbs (230 kg) and a variable load dynamometer sled will be needed.

(2) A test report notebook or similar record forms to be used as a test report work sheets and incorporated into the documentation package.

c. Test Conditions.

(1) The water and the foam tanks shall be full at the start.

(2) The vehicle shall be **fully** loaded with the tires inflated to the manufacturer's recommended operating pressure. Appropriate ballast shall be used as needed to account for the crew and equipment allowances.

(3) The vehicle engine(s) and transmission shall be at normal operating temperature.

d. Test Procedures.

(1) **TEST-I. On Grade.** The vehicle shall be positioned on the flat at the bottom of the 50 percent grade, initiate ascent of the grade, and achieve a speed of at least 1 mph (1.6 km/h). Record the actual speed achieved.

(2) TEST-1A. Alternate On Grade.

NOTE: If an actual 50 percent grade is not available, the vehicle may be coupled to a "50 percent grade equivalent" draw bar load. The load cell reading (in Unit Force per Unit Area) required to simulate the 50 percent grade must equal: $(\sin 26.57^\circ) \times (\text{gross vehicle weight})$ divided by the (unit area of the load cell).

(a) With the vehicle coupled to the appropriate simulated grade, initiate the simulated ascent of the grade, continue the forward motion, and monitor the load cell readings until a speed of at least 1 mph (1.6 km/h) is achieved.

(b) Record the load cell reading and the actual speed achieved.

e. **Pass/Fail Criteria.** The vehicle performance shall be acceptable if grade or the simulated grade is

negotiated smoothly and safely and the vehicle fulfills the standard requirements of paragraph 55.

112. RADIO INTERFERENCE SUPPRESSION.

a. **Facilities.** Those specified in SAE J551 or an equivalent standard approved by the authority having jurisdiction.

b. Equipment Required.

(1) That specified in SAE J551 or an equivalent standard approved by the authority having jurisdiction.

(2) A test report notebook or similar record forms to be used. as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) All electrical devices required by this specification shall be mounted on the vehicle and shall be operational.

(2) The vehicle engine(s) shall be operating at idle.

(3) All vehicle lighting shall be on.

(4) All heat, defrost, and air conditioning systems shall be operating with their respective fans operating at maximum speed.

(5) If provided, auxiliary power generating devices shall be running.

(6) All intermittent warning devices, such as overheat, low pressure or fluid level, high temperature, or vehicle backing warning buzzers; as well as hazard flashers, sirens and horns shall be turned off.

(7) All other vehicle-mounted electrical devices normally functioning at an accident site shall be turned on.

d. Test Procedure.

(1) The procedures required by SAE J55 1 or the equivalent standard shall be used.

(2) The test results shall be recorded and evaluated in accordance with SAE J551 or the equivalent test standard.

e. Pass/Fail Criteria. The radio interference suppression shall be acceptable if it meets the requirements of SAE J551 or the equivalent standard.

113. SIREN SOUND OUTPUT: DIRECTION AND MAGNITUDE.

a. Facilities. This test requires a flat open area where it is acceptable to generate a loud noise for an extended period of time. The area shall not have any large reflecting surfaces, e.g., other vehicles, storage tanks, hills, signboards, or buildings within a **200-foot (60 m)** radius of the test vehicle.

b. Equipment Required.

(1) A tape measure suitable for measuring, 100 feet (30 m) with an accuracy of ± 1 inch and a protractor with an accuracy off 1 degree.

(2) A sound level meter calibrated within the past **12-month** period by a certified testing laboratory. The meter shall meet the requirements of the American National Standards Institute's standard, **ANSI S1.4-1971. for Type 2 Sound Level Meters.**

(3) Sufficient sets of approved earprotection devices for all test personnel:

(4) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions. The vehicle siren/siren speaker shall be mounted in its normal location and be fully operational.

d. Test Procedure.

(1) Measure and mark the locations for three listening posts as follows:

(a) The first shall be at 45 degrees to the left of the longitudinal centerline of the vehicle and 100 feet (30 m) from the left corner of the front bumper.

(b) The second shall be on the centerline and 100 feet (30 m) in front of the front bumper.

(c) The third shall be 45 degrees to the right of the centerline and 100 feet (30 m) from the right corner of the front bumper.

(2) The sound level meter shall be set to the "A-weighting network, fast meter response."

(3) Place the sound level meter at one of the listening posts with the microphone located 5.5 feet (1.65 m) above the ground.

(4) Activate the siren and record the meter reading.

(5) Repeat steps (2) through (4) at the other two listening posts.

e. Pass/Fail Criteria. The siren shall be acceptable if the recorded sound levels meet or exceed the standards of paragraph 8.a.(2).

114. STABILITY: DYNAMIC AND STATIC.

a. Facilities.

(1) Test-1 requires a level, dry, paved surface at least 250 feet (75 m) in diameter, free from loose material. A 100-foot (30 m) radius circle that can be seen and followed by the vehicle driver shall be marked on the surface.

(2) Test-2 requires a tilt table or other suitable surface capable of being tilted, and on which the entire vehicle can be placed. An acceptable alternative is the use of a fixed grade that is equal to the slope requirement for the class vehicle being tested.

(3) Test-2 requires a means to restrain the vehicle at the balance point.

b. Equipment Required.

(1) A calibrated speedometer or other accurate speed measuring device.

(2) A means of measuring steering wheel crank angle.

(3) An inclinometer capable of measuring the slope of the vehicle or the support surface during the tilting procedure with an accuracy ± 0.5 degrees.

(4) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be **used** as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented.

(2) The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(3) If the vehicle is equipped with a **high**-reach, extendible turret, it shall be retracted and secured in its stowed position during these tests.

d. Test Procedure.

(1) **TEST-1. Dynamic Turning Control.**

(a) The vehicle shall be driven at less than 1 mph (1.6 km/h) around the **100-foot** (30 m) radius circle while keeping **the** centerline of the front of the vehicle approximately over the marked circle. After the driver has stabilized the vehicle on this path, a reference mark shall be placed on the steering wheel cramp angle indicator and the actual speed shall be recorded.

(b) The vehicle speed shall be increased gradually until the maximum safe speed (as judged by the driver) is reached. Record the actual speed and steering wheel cramp angle.

(c) Repeat steps (a) and (b) while driving the vehicle in the opposite direction.

(2) **TEST-2. 'Static Side Slope Stability--Tilt Table.**

(a) Tilt the tethered vehicle to an angle at least equal to the side slope angle specified in table 2, Performance Parameter 2, applicable to vehicle class.

(b) Once the vehicle is at the required angle, check the tether lines for tension. If there is tension, reduce the angle until the tension is relieved and record the actual angle achieved.

(3) **TEST-EA. Optional 'Procedure--Fixed Grade Alternative. ,**

NOTE: Before attempting this alternative means of testing side slope stability, the operator should have a high degree of confidence that the vehicle can perform at the required angle. Preliminary tests on lower slopes is strongly advised. A reliable vehicle restraint system that can function while the vehicle is being positioned on the required slope shall be used.

(a) Position the tethered vehicle on a grade having an angle above the horizon at least equal to the standard side slope angle in table 2, Performance Parameter 2, applicable to the vehicle.

(b) Once the vehicle is at the required angle, check the tether lines for tension and record the results.

e. Pass/Fail Criteria.

(1) The dynamic turning control of the vehicle shall be acceptable if it meets the criteria of paragraph 53, the standard in table 2, Performance Parameter 3; for the applicable vehicle class; and the steering' angle required to keep the vehicle on the circular path shall NOT decrease at any time with increasing speed, i.e., oversteer characteristics are unacceptable.

(2) The static **side slope** stability of the vehicle shall be acceptable if it can stand on the applicable standard. grade specified in table 2, Performance Parameter 2, with NO perceptible tension on the tether lines.

115. STEERING SYSTEM: RESISTANCE AND TURNING DIAMETER.

a. Facilities. These tests require a dry, level, paved area that is **free** from loose material and is larger in all directions than three times the length of the vehicle being tested.

b. Equipment Required.

(1) A steering wheel torque meter, a spring scale, or another means of measuring the force applied to the steering wheel rim with an accuracy of ± 2 percent of the value being measured.

(2) A set of wheel chocks.

(3) A device suitable for measuring three times the length of the vehicle being tested with an accuracy of at least ± 1 inch.

(4) Markers or marking device suitable for marking the pavement.

(5) A plumb bob or other device suitable for locating a point on the pavement directly below a fixed point on the vehicle.

(6) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial, center of gravity.

(2) The vehicle steering system shall be fully operational, and the steering linkage stops shall be adjusted to the manufacturer's specified production tolerance limits.

d. Test Procedure.

(1) TEST-1. Resistance or Operating Force Requirements.

(a) With wheel chocks under one set of nonsteering wheels, set the steerable wheels in the straight ahead position, start the engine, engage neutral, and release the brakes. Ensure that the vehicle does not roll.

(b) With the engine at idle speed, measure and record the forces needed at the steering wheel rim to move the steering linkage **from** center to full **left** and full **right** stops. Also measure the force required to move the steering wheel from full left stop to full right stop and visa versa.

(2) TEST-2. Wall-to-Wall Turning Diameter.

(a) The vehicle shall be driven slowly in a full cramp **circle** (**left** or **right**) to establish a steady state in the steering linkage.

(b) Continue driving the slow full cramp circle.

(c) At approximately three equidistant points, (identified as A, B, and C) around the circle, gently stop the vehicle using the service brakes.

(d) At each stop, place a plumb bob against the outermost point of the vehicle and mark the spot on the ground directly below where the **plumb** bob comes to rest.

(e) Measure and record the straight line distances between each pair of points, e.g., Lengths AB, BC, and CA.

(f) Calculate the wall-to-wall turning diameter (**D**) as follows:

Where: $D = 2R$ and

$$\text{Length } S = \frac{[AB + BC + CA]}{2}$$

$$D = 2R = \frac{AB \times BC \times CA}{2 \times [S \times (S-AB) \times (S-BC) \times (S-CA)]}$$

(g) Repeat steps (a) through (f) with the vehicle moving in the opposite direction.

e. Pass/Fail Criteria.

(1) The steering system operating forces shall be acceptable if they meet the standards specified in paragraph 33.a and b.

(2) The steering turning radius shall be acceptable if it meets the wall-to-wall turning diameter (**D** or **2R**) standard specified in paragraph 33.d and table 2, Performance Parameter 8.

116. UNDERBODY CLEARANCES.

a. **Facilities.** This test requires a dry, level, paved area that is **free** from loose material and large enough, to accommodate, the vehicle being tested.

b. Required Equipment.

(1) A device suitable for measuring the vehicle length with an accuracy of ± 0.25 inches (63 mm).

(2) A large protractor suitable for measuring angles with an accuracy off 0.5 degree.

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) The vehicle shall be positioned on-the test area, and the following dimensions shall be measured in accordance with their definitions as stated in appendix 1:

(a) Angle of Approach.

(b) Angle of Departure.

(c) Interaxle Clearance Angle.

(d) Underbody Clearance.

(e) Underaxle Clearance.

(2) The results of the linear dimensions shall be rounded down to the nearest 0.5 inches (1.25 cm) and recorded.

(3) The results of the angular dimensions shall be rounded down to the nearest 0.5 degrees and recorded.

e. Pass/Fail Criteria. The underbody clearances shall be acceptable if they meet the standards of table 2, Performance Parameters 4 through 7, for the applicable vehicle class.

117. VISIBILITY: INCLUDED ANGLES FROM DRIVER'S SEAT.

a. Facilities. This test requires a level site located in a dimly lighted or heavily shaded area that is at least 20 ft. (6.1 m) longer than the vehicle to be tested. Testing may also be performed in the low light of early morning or late evening hours.

b. Equipment Required.

(1) A device suitable for measuring distances up to 50 ft. (15 m) with an accuracy of ± 0.25 inch (63 mm).

(2) A large protractor suitable for measuring angles with an accuracy of ± 0.5 degree.

(3) A plumb bob or other device suitable for establishing a vertical reference point.

(4) A small, sharply focused light source, e.g., flash light, electric pointer, or other light source suitable for establishing the "line of sight" under the available test light conditions.

(5) A device capable of holding the light source that can be adjusted vertically and horizontally to serve as the simulated driver eye location on the driver's seat.

(6) A test report notebook or similar record forms to be used as a test report **work** sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) The driver's seat shall be adjusted to its mid position, with respect to top surface height and the fore and aft adjustment, and have approximately 175

lbs (80 kg) on the seat. The rake of the seat back shall be adjusted to the vertical.

(2) The eye location device shall be placed in the driver's seat and adjusted so as to locate the simulated focal point 31 $\frac{3}{4}$ inches (80 cm) above the seat surface and 6 inches (15 cm) in front of the vertical plane of the **front** surface of the seat back.

(3) The upper and lower limits of the line of sight in the forward direction shall be identified by moving the light beam in the vertical direction until it just touches those obstructions.

(4) Measure and record the angle above and below the straight ahead focal plane where vision **first** becomes obstructed.

(5) Measure and record the distance along the ground from a point directly below the front surface of the front bumper to the point on the ground that is intersected by the light beam at the lowest angle of visibility.

(6) Restrictions to the extreme left and right lines of sight shall be identified by moving the light beam in the horizontal direction, until it just touches those obstructions.

(7) Measure and record the angles **left** and **right** of the straight ahead line of sight where vision **first** becomes obstructed.

(8) At the extreme left and right visibility limits, measure and record the angle below the horizontal focal plane where downward vision **first** becomes obstructed.

(9) At the extreme left and right visibility limits, measure and record the distance along the ground from a point directly below the vehicle surface (that is on the line of sight) to the point on the ground that is intersected by the light beam at the lowest angle of visibility.

(10) Repeat step- 9 as necessary to establish a reasonably smooth arc of visibility between the extreme **left** point, the center point (established in step 6) and between the center point and the extreme right point.

e. **Pass/Fail Criteria.** Driver visibility **from** the cab shall be acceptable if it meets the standards of paragraph 28.d.(1) through (5).

118. VEHICLE INTERIOR NOISE LEVEL.

a. **Facilities.** This test requires that the vehicle be parked at a location so that no large reflecting surfaces, such as other vehicles, signboards, buildings, or hills, are within 50 feet of the driver's seating position.

b. **Equipment Required.** A sound level meter meeting the requirements of the American National Standards Institute's standard, ANSI S 1.4- 197 1 specification for Sound Level Meters, for Type 2 Meters.

c. Test Conditions.

(1) The vehicle shall be tested in fully loaded conditions and at normal. operating temperatures. Engine radiator fans and/or other thermostatically controlled shutters shall be functioned normally. If the vehicle cannot achieve performance parameters with the fan(s) operating, power requirements shall be reviewed.

(2) Park the vehicle in a location that meets the criteria of paragraph a. above.

(3) The driver shall be in the normal seated position at the vehicle's controls.

(4) No other occupants, except the person conducting the test, shall be in the cab during the test.

d. Test Procedure.

(1) Set the sound meter to the 'A-weighting network, "fast" meter response.'

(2) Locate the microphone, oriented vertically upward, 6 inches to the right of, in the same plane as, and directly in line with the drivers right ear.

(3) If the engine is equipped with a governor, put the transmission in neutral and accelerate the engine to the maximum governed speed; OR if it is not equipped with an engine governor, accelerate to the speed for maximum rated horsepower. Stabilize the engine at that speed.

(4) Observe the "A-weighted" sound level reading on **the** meter for the stabilized engine speed condition. If the reading is not being influenced by

extraneous noise sources such as motor vehicles operating on adjacent roadways, record that reading.

(5) Reduce engine speed to idle and repeat the procedures specified in paragraphs d.(3) and (4) above until two maximum sound levels within 2 dB of each other are recorded. Numerically average the two maximum sound level readings, and report the result as the vehicle's interior sound level at the driver's seating position.

e. **Pass/Fail Criteria.** The interior vehicle noise level shall be acceptable if the average noise level measured in accordance with the procedures above meets the criteria of paragraph 28.e. A 2 dB tolerance over that noise level limitation is permitted to allow for variations in test conditions and variations in the capabilities of meters.

119. THROUGH 120. RESERVED.

Section 4. Production Vehicle Performance Acceptance Tests.

121. **PRODUCTION TEST LIST.** The tests listed below shall be conducted by the ARFF vehicle manufacturer on every vehicle. These tests may be conducted at the manufacturer's facility, at the airport, or at another mutually acceptable test site. Specific facilities, equipment, test conditions, test procedures, and the pass/fail criteria for each function to be tested are detailed in paragraphs 122 through 132.

- a. Acceleration.
- b. Air compressor capacity.
- c. Balance/weight distribution.
- d. Brake control.
- e. Foam/water proportioner tolerance.
- f. Foam/water solution pump discharge stability.
- g. Dual pump discharge stability.
- h. Pressure test of piping and-connections.
- i. Bump and roll capability.
- j. Roof turret discharge rate.
- k. Top speed.

122. ACCELERATION.

a. **Facilities.** This test requires a dry, straight, level, paved surface of sufficient length to accelerate the vehicle from 0 to 50 mph (0 to 80 km/h) and to bring it to a safe stop. Sufficient space is needed at each end to turn and reposition the vehicle for a return run.

b. Equipment Required.

(1) The vehicle speedometer and tachometer as installed.

(2) A stopwatch that can be read to ± 0.5 second.

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) Any elevation between sea level and 2000 ft. (600 m) unless otherwise specified by the purchaser.

(2) The vehicle shall be fully loaded. Appropriate ballast may be used as needed to account for the crew and equipment allowances.

(3) The engine(s) and transmission(s) shall be at normal operating temperature.

(4) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) Start with the vehicle at rest, the engine at idle, and the transmission in gear. No "wind-up" of the drive trains shall be permitted.

(2) Simultaneously start the stopwatch and begin accelerating the vehicle. Continue accelerating at full throttle until the vehicle reaches 50 mph (80 km/h), stop the watch, and decelerate/brake to a safe stop.

(3) Record the elapsed time.

(4) This test sequence should be repeated in the opposite direction to cancel the effects of wind and slope. At least three readings in each direction shall be taken. Calculate and report the average acceleration rate.

e. Pass/fail criteria: The acceleration shall be acceptable if the reported average acceleration time meets or is less than the standard of table 2, Performance Parameter 9, ~~for~~ the appropriate vehicle class.

123. AIRCOMPRESSORCAPACITY.

a. Facilities. None.

b. Equipment Required.

(1) The vehicle air system pressure gauge(s) as installed.

(2) A stopwatch, that can be read to ± 0.5 second.

(3) A test report notebook or similar record forms to be used as a test report **work** sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle air system shall be fully operational.

(2) The engine shall be turned off at the start.

(3) The transmission shall be in neutral.

(4) ~~The parking~~ brake shall be set.

(5) The ratio of the actual volume of the installed air reservoir to the minimum required reservoir volume specified in paragraph 32.a.(2) shall have been or must now be established.

(6) The minimum spring brake release pressure must be known.

d. Test Procedure.

(1) Bleed off air reservoir pressure by operating the service brake until the vehicle air gauge(s) indicate less than 85 psi (5.9 Bar).

(2) Start engine and increase speed to maximum governed rpm and monitor the increase in air pressure. When the pressure reaches 85 psi (5.9 Bar), ~~start the~~ stopwatch. If there is more than one air pressure gauge, start the time when the first gauge indicates 85 psi (5.9 Bar).

(3) Continue monitoring the pressure increase until a minimum of 100 psi (6.9 Bar) is indicated on all gauges; stop the stopwatch, shut off the engine, and record the time.

(4) Bleed off air reservoir pressure by operating ~~the~~ service brake until all vehicle air gauge(s) indicate less than 5 psi (0.3 Bar).

(5) Start engine and increase speed to ~~maximum~~ governed rpm and monitor the increase in air pressure. When the gauge for the quick buildup system reaches 5 psi (0.3 Bar), start the stopwatch.

(6) Continue monitoring the pressure increase until the gauge for the quick buildup system reaches the value established for the spring brake release, pressure; stop the stopwatch, shut off the engine, and **verify** that the spring brake release will function at that pressure. Record the time.

e. Pass/Fail Criteria.

(1) **The** acceptable time for pressure in the brake air system reservoir to build ~~from~~ 85 psi to 100 psi (5.9 to 6.9 Bar) shall ~~be 25~~ seconds or less;

OR

(2) If the volume of the reservoir provided is greater than the minimum required by paragraph 32.a.(2)(a), a proportionately longer buildup time shall be acceptable. The allowed time shall be calculated using the formula provided in the referenced paragraph.

(3) The acceptable time **for the** quick buildup system to reach the pressure necessary for spring brake release shall be 12 seconds or less.

124. **BALANCE/WEIGHT DISTRIBUTION.**

a. Facilities.

(1) This test requires an in-ground vehicle scale that is large enough **to** accommodate the appropriate vehicle class and has a **certified accuracy** off 1 percent of the weighed **amount**.

(2) A clean level area **suitable** for **positioning** a large vehicle on a set of **portable**, wheel **scales**.

b. Equipment Required. ,

(1) The in-ground scales described above.

(2) A set of certified **wheel scales with an** accuracy of **±1** percent.

(3) A test report **notebook** or **similar record** forms to be used as a **test** report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be **fully** loaded. Ballast shall be used as, needed to account for the **crew** and equipment allowance. Any **ballast** used shall **be** of appropriate shape and **size and so** located as to accurately represent the item being replaced with respect to the designed center of gravity and payload distribution.

(2) The vehicle shall be **free** of any accumulations of snow, ice, mud or **other** material that could "be **seen**" within **the** accuracy **limits** of the scales.

d. Test Procedure.

(1) **The** gross vehicle weight (**GVW**) shall be measured.

(2) The load on each axle at the **ground** shall be measured.

NOTE: The GVW measured all at once on an in-ground scale will be more accurate than the sum of the individual axle measurements. Hence, the individual axle loads shall be proportionately corrected as needed

to make the sum of their loads agree with the GVW measurement.

(3) The load at the ground **on** each tire shall be measured.

NOTE: Proportionate corrections shall be made to these results as needed to make the sum **of** their loads agree with the corrected load on the respective **axle**.

(4) The following **calculations** shall be made, using the results of the measurements made above.

(a) The percent difference in axle load between the lightest and the heaviest axle load:

$$\frac{\text{Heaviest Axle Ld.} - \text{Lightest Axle Ld.}}{\text{Heaviest Axle Load}} \times 100 = \%$$

(b) The average tire load for each axle:

$$\frac{\text{Wt. on Right Tire(s)} + \text{Wt. on Left Tire(s)}}{2} = \text{Load}$$

(c) The **percent** difference in tire load between the average **tire load** for a given axle **and** 'the **difference** between the heaviest and the lightest tire load for that tire (calculate for e&h tire):

$$\frac{\text{Heaviest Tire Ld.} - \text{Lightest Tire Ld.}}{\text{Average Tire Ld. for Axle}} \times 100 = \%$$

e. Pass/Fail Criteria.

(1) The gross vehicle weight shall be acceptable if it does NOT exceed the vehicle **manufacturer's** gross **vehicle** rating. **The** axle **manufacturer's** published axle ratings shall NOT be **increased to** meet this requirement.

(2) **The** difference between the **heaviest** axle load and the lightest axle load shall be acceptable if it is **NO more** than **10 percent** of the **heaviest** axle load.

(3) The front axle shall NOT be the heaviest loaded axle.

EXCEPTION: The front axle may be the heaviest in those cases where options specified **by** the purchaser' cannot be **practically** engineered to conform with **this requirement**. However, if the front axle is the heaviest, the weight difference between it and any other axle shall not exceed 5 percent. In addition, none of the component ratings **shall** be exceeded to

accommodate this deviation in the balance/weight distribution AND all other performance requirements of this specification shall be met.

(4) The load difference between the tires on a given axle shall be NO more than 5 percent of the average tire load for that axle.

125. BRAKING CONTROL.

a. Facilities. Same as for Prototype Brake System Performance given in paragraph 106.a.(2) or (3).

b. Equipment Required.

(1) The speedometer as installed by the vehicle manufacturer.

(2) A tape measure that can be read to ± 0.5 inches (1.25 cm).

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions. Same as for Prototype Brake System Performance given in paragraph 106.c.(2) through (6).

d. Test Procedure.

(1) Start the vehicle and accelerate to 20 mph (32 km/h) and maintain a constant speed for at least 50 feet (15 m).

(2) Apply the service brake as if in a panic stop; hold the brake on until the vehicle stops.

NOTE: During the panic stop test the driver shall make no steering corrections for vehicle drift during the stop.

(3) In a test lane with outer edge markings, measure and record the perpendicular distance from the nearest edge' line to the outer-most edge of the width of the vehicle. Report the measurement as a negative number if the vehicle is outside of the test lane.

(4) In a test lane with a marked centerline, measure and record the perpendicular distance from the centerline to the outer-most edge of the width of the

vehicle that is farthest from the centerline of the test lane.

(5) Repeat steps 1-through 4 above; EXCEPT that the constant speed shall be 40 mph (64 km/h).

e. Pass/Fail Criteria.

(1) Braking control in a lane with outer boundary markers shall be acceptable if NO portion of the vehicle is outside those boundaries when the vehicle stops.

(2) Braking control in a lane with a marked centerline shall be acceptable if the measured distance is equal to or less than one-half of the vehicle width plus 2 feet (60 cm) when the vehicle stops.

126. FOAM/WATER PROPORTIONER TOLERANCE.

NOTE: May be combined with test in paragraph 127.

a. Facilities. This test requires an open area suitable for discharging a modest volume of foam/water solution at high pressure.

b. Equipment Required. As required for the Foam Proportioning/Foam Concentrate Test ("refractometer test") performed in accordance with NFPA 412, *"Standard for Evaluating Foam Fire Fighting Equipment- on Aircraft Rescue and Fire Fighting Vehicles."*

c. Test Conditions.

(1) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(2) Same as for Foam/water Agent System Prototype Test given in paragraphs 110.c.(1), (3), (4), (5), and (6).

NOTE: Foam proportioner tolerance shall be tested and evaluated at the fixed, minimum acceptable rate per table 3. for each type of applicator.

d. Test Procedure. Same as for Foam/Water Agent System Prototype Test given in paragraph 110.d, Test-1 7; EXCEPT that only the test for foam

concentration, ("refractometer test") shall be performed.

e. Pass/Fail Criteria. The foam concentrate proportioner system shall be acceptable if the foam solution concentration measured for each agent applicator, during individual and combined discharge, at the minimum acceptable discharge rate specified in table 3 for each type of applicator, is within the standard range specified in paragraph 76.

127. FOAM/WATER SOLUTION PUMP DISCHARGE STABILITY.

NOTE: May be combined with test in paragraph 126.

a. Facilities. :

(1) An open site suitable for discharging large volumes of foam/water solution at high pressure.

(2) Access to water and a supply of foam concentrate sufficient to refill vehicle tanks.

b. Equipment Required.

(1) Vehicle pump engine tachometer and agent system discharge pressure gauge as installed by the manufacturer.

(2) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(2) The agent system pressure relief valve shall have been previously verified as being set to the recommended relief pressure.

(3) The temperature of the water and the foam concentrate shall be within the foam manufacturer's recommended operating temperature range.

(4) The water and the foam tanks shall be full at the start.

(5) The foam concentrate proportioners shall be set at the appropriate rate for the foam concentrate to be used at the airport.

(6) The agent selector shall be set for foam/water discharge.

(7) All primary handlines shall be fully deployed.

(8) All applicator nozzles shall be set for straight stream.

(9) If the vehicle is equipped with multiple pumps, they should be operated in parallel during this test.

d. Test Procedure.

(1) The vehicle pump engine shall be started and brought up to maximum recommended operating rpm.

(2) The agent pump(s) shall be engaged and brought up to maximum pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(3) Adjust roof turret elevation to optimum range position and open roof turret discharge valve, observe range of turret stream, continue flow to allow system pressure to stabilize, and observe and record pressure.

(4) Continue turret discharge and initiate discharge from each of the following in its turn: ground sweep or bumper turret, primary handlines (add one at a time), and undertruck nozzles (if provided). All applicators shall be discharging simultaneously in straight stream.

NOTE: As each additional applicator is turned on, the range of the initial turret stream and the initial range of each added appliance stream should be compared by observation and the system pressure observed and, after system pressure stabilization, record the pressure.

(5) Continue discharging with all applicators flowing until the system pressure has stabilized then record pressure and stop test.

e. Pass/Fail Criteria.

(1) The discharge range(s) shall show no signs of deterioration as additional applicators are engaged.

(2) The stabilized system discharge pressure shall not fluctuate by more than 10 percent when comparing the stabilized discharge pressure of the roof turret flowing by itself to the stabilized discharge pressure of the system with all appliances discharging simultaneously.

(3) Foam shall be evident in the discharge stream of all appliances at all times during the test.

128. DUAL PUMP DISCHARGE STABILITY.

NOTE: This test shall be performed only on those vehicles which are equipped with dual pumps and only after they have satisfactorily completed the "Foam/Water Solution. Pump, Discharge Stability" test requirements of paragraph 127.

a. Facilities. Same as paragraph 127.a.

b. Equipment Required. Same as paragraph 127.b.

c. Test Conditions.

(1) All 'foam/water applicator discharge system. performance, requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(2) The agent. system pressure relief valve shall have been previously verified as being set to, the recommended relief pressure and operable.

(3) If the vehicle is equipped with multiple pumps, they shall be operated in parallel during the first half of this test.

d. Test Procedure.

(1) Same as paragraph 127.d.(1) through (5).

(2) Disengage pump number one and repeat test.

(3) Repeat test using only pump number one.

e. pass/Fail Criteria.

(1) The discharge range(s) shall show no signs of deterioration as additional applicators are engaged.

(2) The 'stabilized system discharge pressure shall not fluctuate by more than 10 percent when comparing the stabilized discharge pressure of the roof turret flowing by itself to the stabilized discharge pressure of the system with all appliances discharging simultaneously..

(3) Foam shall be evident in the discharge stream of all appliances at all times during the test.

(4) There shall be NO more than 50 percent, ± 2 percent pressure difference in the stabilized agent system when the results of operating on one pump are compared with two.

129. PRESSURE TEST OF PIPING AND CONNECTIONS.**a. Facilities.**

(1) This test requires an area that provides access to dry compressed air or nitrogen.

(2) The test area shall also provide sufficient clearance between the vehicle being tested and any other valuable property so as to preclude damage in the event of a pipe or fitting failure.

(3) The test area shall also provide for appropriate protection for the test personnel against possible flying debris from a component failure.

b. Equipment Required.

(1) A. gauge, suitable for the intended service with an accuracy of ± 5 psi and a working range equal to 2.0 times the normal agent system operating pressure..

(2) A means of developing and delivering pressure equal to 1.5 times the normal agent system operating pressure..

(3) Miscellaneous plates, caps and fittings suitable for isolating the suction side of the agent system, if necessary and a suitable leak detection solution.

(4) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into **the documentation package**.

c. Test Conditions.

NOTE: It is often easier and/or more convenient to perform this test before the vehicle **body** is **completely** assembled with the **agent** system controls in place. Therefore, **the** agent system **does** not have to be **fully** operational for this test.

(1) The agent system piping shall be **fully** assembled, i.e., no **subsystem** testing is permitted.

(2) All suction side piping components which cannot **tolerate** the test **pressures** shall be isolated from the discharge system.

(3) Agent pumps shall be included in the discharge system test.

(4) All agent discharge **outlet valves** shall be closed.

(5) All bypass lines **from** the discharge system to the water and **foam** Concentrate **tanks** shall be blocked **during the** test.

(6) The agent **pumps** and **all discharge** piping shall be filled with water.

d. Test Procedure:

(1) **Pressurize** the agent discharge system to at least 1.5 **times** the maximum recommended system operating pressure:

(2) Isolate the agent **discharge** system in the pressurized condition by closing the test pressure supply **line** inlet valve **and** lowering the supply device pressure.

(3) Record the pressure and monitor the system pressure for at least 30 minutes.

(4) If **the** pressure drops, the leaks shall be located, repaired, and the test shall be repeated until the pressure can be maintained for at least 30 minutes.

(5) Upon **completion** of the **test**, **remove any** discharge/suction **system** **isolation** **devices** and reassemble the suction piping.

(6) The water **and foam concentrate** tanks shall be filled, and the suction piping inspected **for** leaks during and **immediately after** the agent system has been operated **in the foam/water solution** discharge mode.

e. Pass/Fail Criteria.

(1) No pressure decay shall be **permitted** during the **30-minute pressure holding** period.

(2) No leaks **shall be** permitted in the discharge or suction piping during or after agent system **operation**.

130. PUMP AND ROLL CAPABILITY.

a. Facilities. Same as for the Foam/Water Agent System Prototype Test; **paragraph 1 10.a.(1), (2) and (4).**

b. Equipment Required. Same as for the Foam/Water Agent System Prototype Test; **paragraph 1 10.b.(2), (6) and (11).**

c. Test Conditions.

(1) The vehicle agent system shall be **fully** operational.

(2) All foam/water applicator discharge **system** performance requirements shall **have** been previously verified by prototype tests **as specified** in paragraph 105.

(3) Same as for the Foam/Water Agent System, Prototype Test; **paragraph 1 10.c.(1) and (3) through (8).**

d. Test Procedure. Same as for the Foam/Water Agent System Prototype, **Tests-14 and -15, paragraph 110.d.**

e. Pass/Fail Criteria. Same as for the Foam/Water Agent System **Prototype, Tests-14 and -15, paragraph 1 10.e.(19) through (23).**

131. ROOF TURRET DISCHARGE RATE.

a. Facilities. Same as for the Foam/Water Agent System Prototype Tests-11 or -11 A, paragraph **110.a.(1) and (4).**

b. Equipment Required. Same as for the Foam/Water Agent System Prototype Tests- 11 or -11 A, paragraph 1 10.b.(2), (3), (4), (7), (8) and (11).

c. Test Conditions.

(1) The vehicle agent system shall be fully operational.

(2) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(3) Same as for the Foam/Water Agent System Prototype Tests- 11 or -11 A, paragraph 11 0.c.(1) and (3) through (8).

d. Test Procedure. Same as for the Foam/Water Agent System Prototype, Tests-1 1 or -11 A, paragraph 110.d.

e. Pass/Fail Criteria. Same as for the Foam/Water Agent System Prototype, Tests-1 1 or -1 1A, paragraph 1 10.e.(16).

132. TOP SPEED.

a. Facilities. This test requires a dry, straight, level, paved surface of sufficient length to accelerate the vehicle to 65 mph (104 km/h) and to bring it to a rapid stop, safely. **Sufficient** space is needed at each end to turn and reposition the vehicle for a **return** run.

b. Equipment Required.

(1) The vehicle speedometer and tachometer as installed.

(2) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) Elevation between sea level and up to 2,000 **ft.** (600 m) unless otherwise specified by the purchaser.

(2) The vehicle shall be fully loaded to include ballast, as appropriate, for the crew and equipment allowance.

(3) The engine(s) and the transmission(s) shall be at normal operating temperature.

(4) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) Start with the vehicle at rest, the engine at idle, and the transmission in gear.

(2) Simultaneously start the stopwatch and begin accelerating the vehicle. Continue accelerating at full throttle until the vehicle reaches at least 65 mph (104 km/h). Record the speed actually achieved.

(3) This test sequence should be repeated in the opposite direction to cancel the effects of wind and slope. At least two readings in each direction shall be taken to calculate the reported average top speed.

e. Pass/fail criteria. The reported average top speed shall be acceptable if it meets or exceeds the standards specified in paragraph 57.

...and the fact that the *in vitro* and *in vivo* results are in good agreement.

APPENDIX 1. DEFINITIONS.

Section 1. Introduction.

1. Aircraft rescue 'and **firefighting** (ARFF) is a relatively new branch' of **the** firefighting profession. There are approximately one 'million paid, part-time, and volunteer **firefighters** in the United States and Canada. Thousands of new members, **who** are' unfamiliar with basic fire service terminology, join the ranks each year. The unique terms used by 'airport firefighters in the performance of their duties **further** complicate the communications problem. Because, of the small number of **firefighters** at most **civil airports**, &port/community 'disaster plans and **the** various mutual aid arrangements must involve many traditional structural **firefighters**. In order to work 'effectively together, these mixed forces must understand **each other**.

2. It **is** recognized that many geographical and technical dialects exist among fire service personnel and consultants. Hence, **the** terms in this appendix were assembled from 'a variety of individuals and institutions.

A special effort was made to observe precedence in usage. That is, where a recognized authority such as the International Civil Aviation Organization, **the** National Fire Protection Association, the National Transportation Safety Board, the Federal Aviation Administration, **the** structural **fire** service, or a specific equipment industry has historically used a word or phrase with a widely accepted meaning, it was adopted for use in this guide specification and is included in this appendix to encourage universal use and to enhance understanding.

8. No attempt has been made to include words which are clearly understood by qualified fire fighters and non-fire fighters alike or the many unique words that seem to be related only to structural **firefighting** activities. Instead, the list is limited to the words and phrases which are most definitive of aircraft rescue and **firefighting** activities and aircraft rescue and **firefighting** vehicles.

Section 2. Definitions

4. **Acceptance Tests.** Tests conducted on every vehicle by the manufacturer to assure that:

a. Each vehicle is fully operational when delivered.

b. The original level of performance verified by the prototype vehicle tests continues.

5. **AFFF.** See Aqueous Film Forming Foam.

6. **Aggressive Tire Tread.** Tread designed to provide a maximum of traction for most types of service.

7. **Air-Cooled Engine.** One in which removal of waste heat from the cylinder walls is by **direct** transfer to the atmosphere by a moving air stream.

8. **Air-Mechanical Brakes.** Brakes in which **the** force from an individual air chamber directly applies the force to the friction surfaces through a **mechanical** linkage.

9. **Air Over Hydraulic Brakes.** Brakes in which **the** force of a master air cylinder applies the force to the friction surfaces through an intervening hydraulic system.

10. **Ambient Temperature.** The temperature of the **environment** surrounding a vehicle at any given time.

11. **Angle of Approach or Departure.** Describes the steepest ramp 'that a fully loaded vehicle can approach and ascend (or descend and depart) **from** a connecting horizontal surface without interference from any part of the vehicle. It is **the** angle bounded by the horizontal ground line and the line tangent to the loaded.. radius of the **front/rear** tire and the first structural part or vehicle accessory that it encounters as the angle increases above the horizontal.

12. **Approved.** Acceptable to the "authority having jurisdiction."

13. **Aqueous Film Forming Foam (AFFF) Concentrate.** A concentrated aqueous solution of fluorinated surfactants and foam stabilizers which,

when mixed with water in designated **proportions**, is capable of producing an aqueous fluorocarbon film on the surface of hydrocarbon **fuels**.

14. Authority Having Jurisdiction. The organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

15. Automatic Locking Differential. A type of non-slip differential that operates automatically.

16. Axle Tread. The **distance between** the center of two tires or wheels on the opposite ends of one axle.

17. Bogie. A tandem arrangement of aircraft or ground vehicle wheels and axles. The bogie axles can move semi-independently, so that all wheels follow the ground as the attitude, of the, **aircraft** or vehicle changes or the ground surface changes. For example, in a 6 x 6 vehicle, where there are two axles at the rear of the vehicle to support the weight 'on the rear, this two-axle combination is the "rear bogie." An 8 x 8 vehicle with two axles on each **end would have** a front bogie and a rear bogie.

18. Center of Gravity. The point within a vehicle at which all of its weight may be considered to be concentrated. When a vehicle is tipped to a degree that a vertical line passing through the center of **gravity** falls on the ground outside the axle tread track, it is unstable and will turn over easily.

19. Chassis. The assembled frame, engine, drive train; and tires of a vehicle.

20. Combined Agent Vehicle. An ARFF vehicle which carries foam/water as the **primary** extinguishing agent and either a dry chemical, **Halotron I** or approved equivalent, or another acceptable **agent** as the complimentary agent. A "dual agent" vehicle is one designed so that the 'turret **and/or handline** can separately or simultaneously discharge both primary and complimentary agents.

21. Component Manufacturer's Certification. A signed application approval furnished by the manufacturer certifying that the 'component in question is acceptable as being:

a. Properly installed.

b. Suitable for service as applied in the vehicle for its intended use.

c. In compliance with the respective construction criteria required by the Standard.

22. Coolant Preheater Device. A device for heating the engine coolant so the engine maintains a constant temperature. It usually **consists of** a coolant jacket and an electric heating element. The engine coolant flows through the preheater jacket and **absorbs heat from** a heating element. **The** heating element obtains **its** power **from** an outside source; 'thereby, holding **the** engine **coolant** at a temperature recommended for 'fast starting.

23. Critical Rescue and Firefighting Access Area. The rectangular area on an airport surrounding **any** runway within which historical data has **shown that** most aircraft accidents can be expected to occur. The National Fire Protection Association (**NFPA**) describes it as an area included by a rectangle which extends in width 500 **ft** (150 m) on each side of the centerline of the runway times a length which includes the runway plus 3,300 **ft** (1,000 m) beyond each end of **the** runway.

Area in **ft**² = 1,600 **ft** x [runway length(k).+ 6,600 **ft**]

OR

Area in **m**² = 300 m x [runway length(m) + 2,000 m]

24. Dual Agent Nozzle or Turret. A firefighting appliance designed 'to dispense foam and a complimentary agent; individually or simultaneously.

25. Eductor. A device designed to proportion liquid foam concentrate into a foam/water system. The device may be part of a vehicle foam agent system or it may be portable.

26. Film Forming Foam. A foam liquid concentrate, when mixed in appropriate proportions **with** water and applied to the surface of a flammable liquid, forms a film on the surface of the fuel which suppresses vaporization with or without the presence of visible foam.

27. Fluid Coupling. A turbine-like device which transmits power solely through the action' of a fluid in a closed circuit, (i.e., no direct -mechanical connection between input and output shafts) and without torque multiplication.

28. Fluoroprotein Foam Concentrate. A protein foam concentrate incorporating one or more

fluorochemical surfactants to enhance its tolerance. to **fuel** contamination.

29. **Foam Expansion Ratio.** The number used to express the relationship between the volume of foam produced and the volume of water/foam solution used in its production.

30. **Foam Liquid, Concentrate Percentage.** The numerical designation of the amount of foam-liquid concentrate in solution with water.

31. **Fully Loaded Vehicle.** The fully assembled vehicle, complete with a compliment of crew, fuel, equipment, and firefighting agents. The crew allowance shall be 175 pounds (90 kg) per seating position. Unless, otherwise **specified**, the equipment allowance is a maximum of 1,000 pounds (450 kg). Where the customer specifications require carrying more equipment, the actual weight of the equipment is also part of the GVW for performance tests.

32. **In-Service Condition.** A state, or' condition of readiness for intended duty. Usually an emergency vehicle properly serviced with all equipment properly loaded and ready for immediate response, i.e., a fully loaded vehicle.

33. **Interaxle Clearance. Angle (Ramp Angle).** Describes the sharpest "height of land" over which a vehicle can pass without **hanging** up. Clearance is determined by the angles formed by the horizontal ground line between the closest forward and rear axles and whichever of the following lines form the smallest angle:

a. The line tangent to the, loaded radius of the **front** tire, extended rearward to that fixed point on the vehicle, ahead of a vertical line midway between, the two axles, which will determine the smallest **angle**.

b. The line tangent to the loaded radius of the rear tire, extended forward to that fixed point on the vehicle **behind** a vertical **line** midway between the two axles, which will determine the smallest angle.

34. **Interaxle Differential.** A differential in the line of drive between any two axles.

35. **Lightweight Construction.** Intended to indicate the use of nonferrous metals, composites, or plastics or a reduction in weight by the use of advanced

engineering practices, resulting in a weight saving without sacrificing strength, durability, or efficiency.

36. **Listed.** Equipment or materials included in a list published by **an** organization (acceptable to the "authority having jurisdiction") concerned with product evaluation. The organization performs periodic inspection of production, items of the listed equipment or materials. Its listing, states either that the equipment or materials meets appropriate standards or passes tests and, therefore, **has** been found suitable for use in a specified manner.

37. **May.** **This term** states a permissive use or an alternative method to meet a-specified requirement.

38. **No-load Condition.** An engine with standard accessories operating without an imposed load, with **the** vehicle drive clutches and any special accessory clutches, in a disengaged or neutral condition.

39. **Off-Pavement Performance.** This refers to a **vehicle's** ability to **perform** or operate on other than paved surfaces. These "**other** than paved surfaces" include dirt roads, trails, and a wide. variety of open cross country terrain. **Other** references to this capability may be **in** terms of "off-road mobility" or "cross country mobility." These -three terms are synonymous.

40. **Overall Height, Length, and Width.** The dimensions determined with the "vehicle fully loaded and equipped. Unless otherwise specified, the measurements shall include all protrusions which could in any way hinder the **passage** of the vehicle. Dimensions determined for movable protrusions shall be with **the** protrusion 'in its normally stored position.

41. **Percent Grade.** The ratio of the change in elevation (**rise**) to the horizontal distance (run) traveled multiplied by **100**. **Example:** A change in elevation of 50 feet (15 m) over a horizontal distance of 50 feet (15 m) is a **100-percent** grade. This is also known as a **45-degree** angle or 1: 1 slope.

42. **Power-Assist Steering.** A system using **hydraulic** or air power to aid in the steering. This system is supplementary to the mechanical system required to preserve steering ability in event of power failure.

43. **Protein Foam Concentrate.** A concentrated solution of hydrolyzed protein plus stabilizing additives and inhibitors to protect against freezing, prevent

corrosion of equipment and containers, resist bacterial decomposition, control **viscosity**, and otherwise, assure readiness for use.

44. Prototype Vehicle. The first of a **unique vehicle** configuration built to **establish** the performance capability, not only of **itself**, but of all subsequent vehicles manufactured from the same basic drawings and parts list. A given: chassis, body, **firefighting** system, and fully loaded Weight condition shall constitute a vehicle configuration; Product improvements and/or customer options **shall negate** a given, previously conducted, prototype test only if the changes can be reasonably expected to materially affect the given performance factor:

45. Radio Interference Suppression. Suppression of the ignition and electrical: system noises which normally interfere with radio transmission and reception.

46. Rubber-Gasketed Fitting. A device for providing a **leak-proof** connection between **two** pieces of pipe while allowing moderate movement of one pipe relative to the other: It incorporates a rubber seal held in place by a two-piece clamp that **also engages** annular grooves near the end of each pipe to prevent pullout under pressure.

47. Shall. Indicates a mandatory requirement.

48. Should. This term indicates a recommendation or advice but not a requirement.

49. Steering Drive Ends. The ends/stub shafts in the wheel spindle in a 'driving-steering **axle** used 'on the steering axle(s) of an **all-wheel** drive ARFF vehicle.

50. Torque Converter. A **device similar** to the fluid coupling but which, by means of additional turbine blades, results in torque multiplication

51. Ton. This unit equals **2,000** US pounds (907 kg).

52. Twenty-Five Percent Drainage Time. The time, in minutes, that it takes for 25 percent of the total

liquid contained in a known **volume** of **foam** to drain out. It is one means of evaluating the performance of foam producing devices. NFPA 412, **Standard for Evaluating Foam Firefighting Equipment on Aircraft Rescue and Firefighting Vehicles**, gives a method of measuring drainage time.

53. Underbody or Underchassis Clearance. The **minimum** dimension between the **ground** and any components of the vehicle, except those that are part of the axle assemblies, which could hinder the **passage** of the vehicle. This dimension is determined with the vehicle fully loaded and fully equipped, unless otherwise specified.

54. Unitized Rigid Body and Frame Structure. A form of vehicle construction that integrates parts (generally comprising a separate body) with the chassis frame to form one rigid, load-carrying structure.

55. Unsprung Weight. The total weight of all vehicle components which are **not completely** supported by the **suspension system**.

56. Vehicle Drive Nomenclature. Common vehicle references are 4 x 2, 4 x 4, 6 x 6, and 8 x 8. In the use of this nomenclature, the first number indicates the total number of wheels on the vehicle and the second number is the number of driving **wheels**.

57. Wall-to-Wall Turning Diameter. The smallest diameter circle described by the outermost point on the vehicle as it negotiates a **360-degree** right or left turn.

58. Weather Tight. Compartment closure **sufficient** to prevent rain, snow, wind-driven sand, dirt, or **dust** from penetrating under most operating conditions. It is **not** necessary to be water tight; vapor tight, **dust** proof, or submersible.

59. Weight Scale Measurement. The accurate measurement of vehicle weight by means of a scale to verify or check a stated or estimated weight.

APPENDIX 2. OFF-PAVEMENT MOBILITY.

Section 1. Background.

1. There have been many attempts by individuals and institutions to identify the controlling parameters in the design of ARFF vehicles suitable for both paved and off-pavement service. While this **capability** is evasive, easily misunderstood, and expensive to achieve, it is a necessary one.

2. A review of the available aircraft accident statistics should convince even the most skeptical of the need for good off-pavement performance. For example, when past accident locations are mapped as is shown in figure A2-1, one can clearly see that a large percentage of the aircraft accidents occur off runways and other paved surfaces. Hence, to be truly effective, ARFF vehicles require certain off-pavement **mobility** capabilities while retaining general highway performance requirements.

3. In addition, a review of figure A2-2 supports the premise that the highest potential benefit in terms of reducing future aircraft accident deaths by fire can be obtained by achieving the capability to **perform** the ARFF service life **safety** mission in the off-pavement environment of the airport. This capability is most effectively achieved through two complementary efforts.

4. First, survey the airport in question to identify those areas which lie within the airport's "Critical Rescue and Fire Fighting Access Area" (CRFFAA) that can not be traversed by the existing fleet of **straight-framed**, wheeled vehicles. See figure A2-1. If the size and/or distribution of these non-traversable areas is small relative to the CRFFAA, preplan alternate access routes (permanent or seasonal as may be appropriate) to potential accident sites and train the vehicle operators to avoid the use of these **non-traversable** areas during an emergency response. The objective of providing such a training program for the designated ARFF vehicle operators is to ensure that they are familiar with the preferred alternate routes to likely accident sites, have knowledge of the operational limitations of **their** specific vehicles, and have the

opportunity to practice their off-pavement driving skills over the designated alternate routes.

5. If the action taken above still leaves the airport with relatively large sections of **difficult** terrain, e.g., low soil strength, grades over 10 percent, rocky areas, swamp lands, deep snow, or bodies of water, which lie inside the airport's CRFFAA, the ARFF system manager should consider the specification of an ARFF service vehicle other than the ordinary **straight-frame**, wheeled **ARFF vehicles**. Examples of such vehicles **are**: straight-frame tracked; articulating, wheeled or tracked; **amphibious**, air cushioned or a combination of these **types**.

6. The off-pavement performance characteristics of any ground supported **vehicle** depend on numerous factors. Although **considerable** progress has been made in the continuing effort to identify these factors and to design for the controlling parameters of **off-pavement** vehicle performance, there are still many with which to deal. Never-the-less, the **following** factors, while not all inclusive, have been identified as important considerations in specifying a vehicle for **off-pavement** ARFF operations. Primary among those factors identified **are** the capabilities of the driver; topography **of** the area and soil trafficability; the vehicle's total geometric; inertial, and mechanical characteristics as well as the tire selection.

7. It is well known that ARFF vehicles with special mobility **requirements** or the adaption of unique vehicles **for** ARFF service is expensive. Therefore, any special vehicle performance criteria identified as a result of an assessment of the airport's off-pavement mobility requirements must be addressed in quantitative terms **to the maximum** extent possible. In other words, the purchaser should make it perfectly clear what the **ARFF** vehicle manufacturer is being asked to provide...before the bids are opened.

8. THROUGH. 19. RESERVED.

Section 2. Tire Selection.

20. Tire diameter, Width, inflation pressure, and deflection (as related to **the** loads imposed) are

important basic elements. The use of treads designed

Appendix 2

to provide traction, skid resistance, and self cleaning is an allied consideration.

21. To optimize vehicle performance characteristics, i.e., achieve the best combination of acceleration, speed, braking, and maneuvering **capabilities** for both on and off-pavement, both the vehicle and the tire manufacturers must have accurate information about the intended service environment.

22. When local conditions require high floatation, (sand, mud, snow, etc.) and good traction for off-pavement mobility, vehicle tires shall have a tread suitable to develop a **drawbar** pull of 0.4 times the vehicle weight on a level, clean, clay surface, (CL in USCS Soil Classification System) with a **strength of** 200 or greater Rating Cone Index (**RCI**) **immediately** after a 1/2 inch per hour rainfall intensity storm.

23. THROUGH 29. RESERVED.

Section 3. General Topography and Soil Trafficability.

30. The US Army Corps of Engineers at the Waterways Experiment Station, at Vicksburg, Mississippi, has, over a period of 30 years of testing, developed an approach to this multifaceted parameter which they call the vehicle cone index (VCI). The VCI is a method of estimating the probability of a vehicle of given characteristics successfully operating in a given off-pavement soil condition... Although, **not** accepted by some ARFF vehicle manufacturers, the concept **is** certainly noteworthy.

31. Furthermore, it is, strongly recommended that anyone planning to develop a specification for an ARFF vehicle, pay particular attention, **to** the uniqueness of the entire off-pavement environment: at their specific airport. As discussed earlier, special attention should be given to the unpaved surfaces inside the CRFFAA. If **there** is any **doubt**, about accident site 'accessibility due to, questionable soil trafficability, a soil strength survey should be performed to determine the VCI of proposed access routes. The survey should be conducted during the time of year when the strength of the soil involved is at its poorest. This **additional** effort could pay big dividends in terms of cost-effectiveness.

32. VCI is a means of determining vehicle weight bearing requirements compared to soil strength (cone index) in a particular situation. The calculated VCI number for the vehicle should be less than **the** measured soil strength in a particular situation to assure successful operation. Vehicles operating **on** different types of soil will exhibit different levels of traction performance. Therefore, separate computations are required to predict soil-vehicle performance for **fine-grained** and coarse-grained soils.

33. In general, the vehicle having the lowest VCI will have the highest probability of negotiating a given off-pavement condition. If as a result of a soil strength survey the VCI is going to be used as a selection criteria it must be clearly identified as a performance requirement item **in** the request for bids. And, the manufacturers should be required provide the VCI for their specific vehicle design as part of their bid response.

34. THROUGH 39. RESERVED.

Section 4. Geometric, Inertial, and Mechanical Characteristics.

40. The full acceleration and top speed characteristics of the vehicle required in chapter 2, section 7 and table 2 are not, in and of themselves, very **useful** in the off-pavement environment. However, the power required to produce that performance has a second, equally important function. In a well designed vehicle, the same power needed to meet the acceleration and top speed requirements can also be used to maneuver@ the off-pavement environment. The requirement for that power has been **quantified** in paragraph 55. "Gradability".

41. The same vehicle design features which, in the aggregate, produce unstable performance in the operational environment on paved surfaces is magnified in the off-pavement situation. Hence, it must be emphasized that stability is a 'must have' item in any ARFF vehicle. These characteristics have been quantified in terms of both static and dynamic stability in paragraph 53.

42. It is also important that a vehicle intended for off-pavement service be designed to minimize the potential

for getting hung up on obstacles commonly encountered in the intended operational environment. Although universal agreement may never be reached, a significant degree of standardization has been attained. Items of particular concern are: angles of approach, departure, and interaxle clearance; underbody and underaxle clearances, and **wall-to-wall** turning' diameter. Quantified requirements for these items can be found in table 3.

43. Specifying unique values for other physical, **non-**performance related features such as overall height, width, length, exact turning radius, or gross vehicle weight becomes very complex and, with very few

exceptions, contributes nothing to the enhancement of the vehicle's off-pavement mobility performance capability. In general, these features are payload dependent. Put another way, before these dimensions/clearances can be optimized the specific payload characteristics must be identified. As the independent variable, payload tends to dictate the practical range within which such features can be specified. In addition, the **final** result is usually the byproduct of a specific manufacturer's overall design approach; and, as a result are often proprietary in nature.

44. through 49. 'Reserved

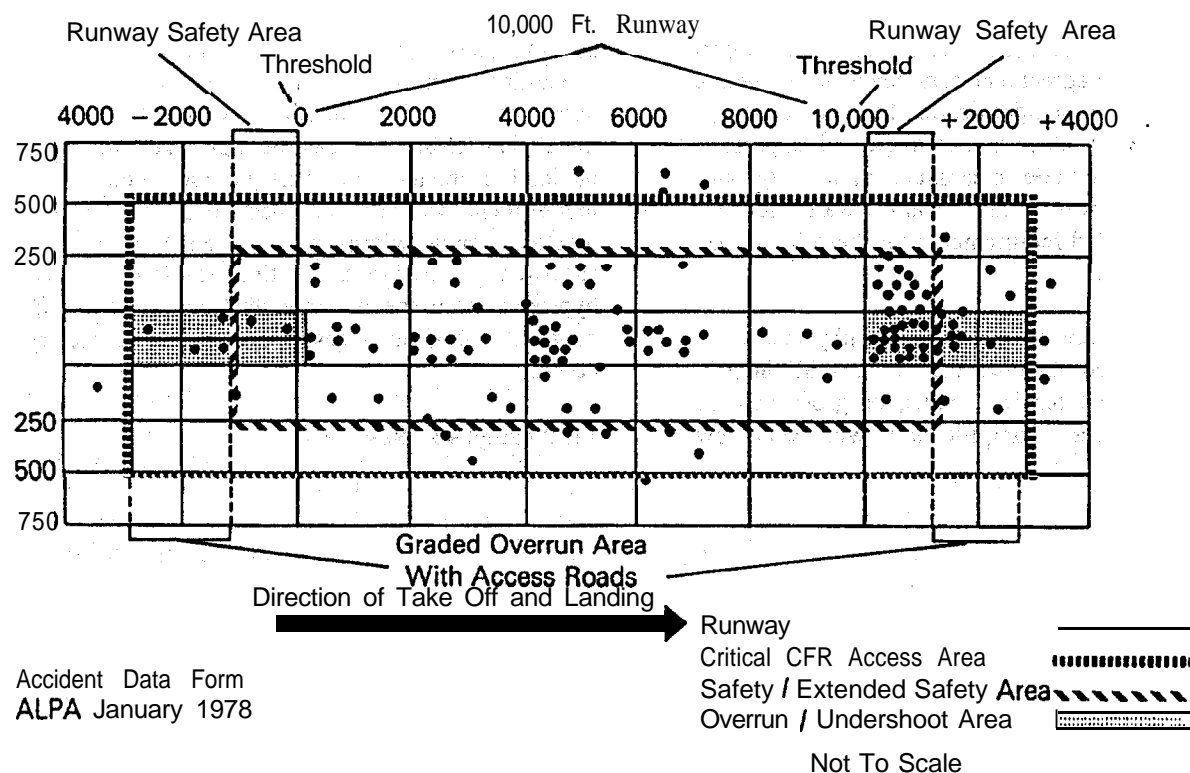


Figure A-2.1. Accident Site Locations and the Critical ARFF Access Area.

408 Impact Survivable Accidents/Incidents Involving Fire

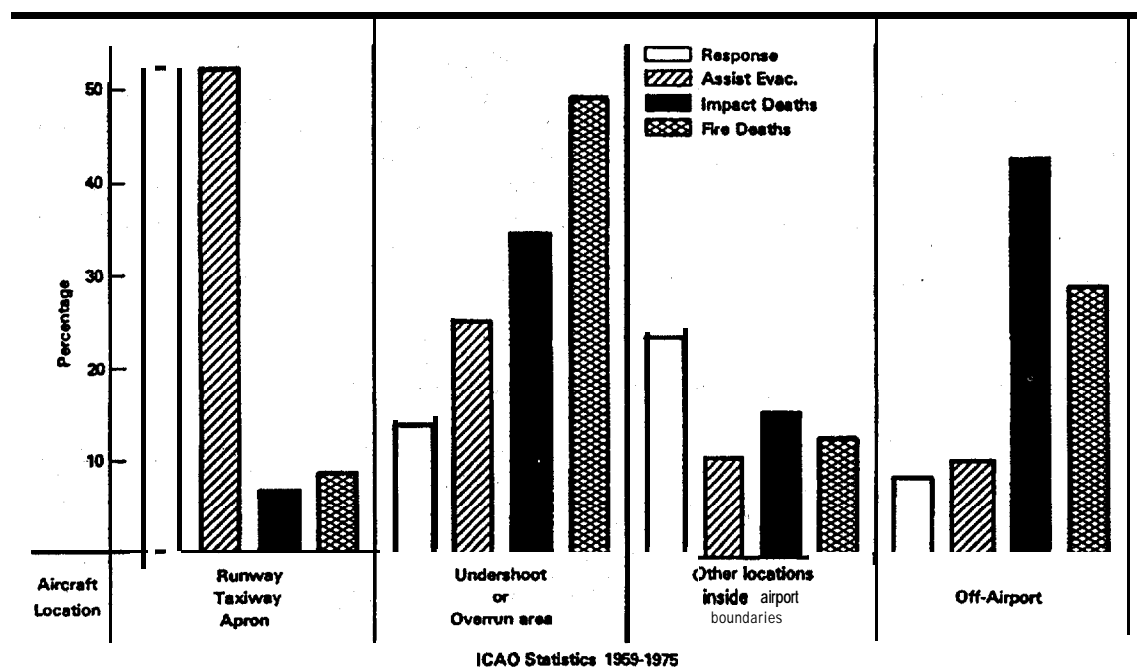


Figure A-2.2. Areas for Potential Off-Pavement ARFF Operations.

APPENDIX 3. EQUIPMENT FOR AIRCRAFT RESCUE AND FIREFIGHTING OPERATIONS.

Section 1. The Selection Process.

1. Aircraft rescue and **firefighting** (ARFF) operations require a wide variety of both personnel safety and general use equipment and **tools**. The selection of a range of rescue equipment and tools that are both **cost-effective** and appropriate for the ARFF equipment inventory at a given airport depends upon a number of considerations. For example:

a. Is the staffing both adequate and trained to actually make effective use of the item?

b. Are some or all of the more expensive, **low-use** items available from another source that can reasonably be expected to provide them in a timely manner through a **mutual** aid agreement?

c. If the necessary expertise is not available at the airport, can the equipment be operated by a mutual aid responder who is readily available and has the training necessary to participate effectively in ARFF operations on the airport?

d. Is the purchase of the needed items as part of the new ARFF vehicle package the most cost effective means of obtaining them? In some cases a local fire protection equipment supply company can provide a customized selection of the appropriate items at a better price than can a vehicle manufacturer who must first obtain the items from a similar source and then pass on the administrative costs.

e. Are special cabinet sizes and/or hold-down devices required to safely and securely store and transport some of the items selected? These

requirements are most cost effectively accommodated during initial construction.

2. **Regardless** of the source (new with the vehicle, new from an equipment supply company, or existing equipment to be transferred **from** an old vehicle), the decision as to what specific items are to be carried by a given vehicle should be made in advance of the purchase of a new vehicle. In addition, airports **with** more than one ARFF vehicle have the option to distribute the weight and bulk of the selected equipment among/between the available vehicles.

3. During the selection process, it should be kept in mind that where a rescue tool requires a power source for its operation, a decision must be made as to the means of providing it. For example:

a. Some pneumatic chisels, saws, and drills can operate from compressed-air cylinders or small internal combustion engines. These offer complete equipment mobility. However, with the latter a minor risk of a potential ignition source is introduced.

b. On the other hand, more complex rescue tools use pneumatic, hydraulic, or electrical power in sufficient quantities to require the support of stand alone power units. This requires yet another decision; vehicle-mounted power units with the range limitations imposed by the power cables or portable power units to be carried in the vehicle. These often require more personnel to operate effectively in the field.

4. **THROUGH 19. RESERVED.**

Section 2. General Use Equipment and Tools and, **Personnel** Protective Equipment.

20. A list of recommended equipment and tools is given in table **A3-1**. The range of equipment is broken

out by both certificated airport ARFF Index and general aviation airports.

Table A3-1. Recommended Equipment For Rescue Operations (Page 1).

	AIRPORT ARFF INDEX OR CATEGORY			
	GA-1	GA-2 & A	B-C	D-E
CHOCKS, 4 inch (10 cm) high	1	1	-	-
ROPE LINE, 50 Ft. (15 m) length	1	1	-	-
AXE, rescue, small non-wedge type	1	2	4	4
BLANKET, fire resistant	1	1	2	2
CUTTER, bolt 24 inch (61 cm)	1	1	1	1
CROWBAR, 36 inch (95 cm)	1	1	1	1
FLASHLIGHT	2	3	4	8
GLOVES, flame resistant (pairs) unless issued to individual crew members	2	3	4	8
HARNESS CUTTING TOOL	1	2	3	4
HOOK, grab or salving	1	1	1	1
HACKSAW, heavy duty with spare blades	1	1	1	1
MEDICAL KIT, first aid/first responder	1	1	1	1
PROTECTIVE CLOTHING	*	*	*	*
PLIERS, side cutting 7 inch (17.8 cm)	1	1	1	1
PLIERS, slip joint 10 inch (25 cm)	1	1	1	1
SAW, powered rescue complete with two spare blads, OR	1	1	1	2
CHISEL, pneumatic complete with spare air cylinder, chisel blade, and retaining spring	1	1	1	2
SCREWDRIVER SET, assorted sizes & blade type	1	1	1	1
SNIPERS, sheet metal straight cut	1	1	1	1
WRENCH, adjustable	1	1	2	2

* *Approved protective clothing complete sets, of a type appropriate to the ARFF tasks to be performed, of the correct size and in sufficient numbers to provide all personnel who are expected to participate in ARFF activities with a set.*

Table A3-1. Recommended Equipment For Rescue Operations (Page 2).

	AIRPORT ARFF INDEX OR CATEGORY			
	GA-1	GA-2 & A	B-C	D-E
** AIR CYLINDERS, SPARE (SCBA)	-	2	4	8
AXE, rescue, large nonwedge type	-	1	1	1
** BREATHING APPARATUS WITH CYLINDER, (SCBA)	-	2	4	8
CHISEL, cold 1 inch (2.5 cm)	-	1	1	1
FORCING TOOL, hydraulic or pneumatic	-	1	1	1
HAMMER, 4 pound (1.8 kg)	-	1	1	1
LADDER, extension (appropriate overall length)	-	1	2	2 or 3
SKIN PENETRATOR - - AGENT APPLICATOR	-	1	1 or 2	2
CHOCKS, 6 inch (15 cm) high	-	-	1	1
CROWBAR, 5.5 Ft. (1.65 m)	-	-	1	1
ROPE LINE, 100 Ft. (30 m) length	-	-	1	1

*****The quantities recommended are nominal. Managers of ARFF services should be aware that certain National Consensus Standards as well as State and Federal OSHA work place safety standards relating to firefighting operations and the use of self contained breathing apparatus may be applicable to their jurisdiction. Hence, additional SCBA units may be required and special training and/or operator certification may be needed.***

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APPENDIX 4. PURCHASER ELECTION OF SUBSYSTEM COMPONENTS.

Section 1. Background.

1. The Federal Aviation Administration, airport sponsors, and manufacturers of airport rescue and firefighting vehicles, working together, created an **ARFF** vehicle specification (Advisory Circular 150/5220-1 OB, Guide Specifications for Water/Foam Aircraft Rescue and Firefighting Vehicles) based on quantitative and verifiable performance criteria.

2. This guide specification is intended to permit manufacturers to bid competitively and to preclude the need for the purchaser to be involved in materials selection. It does however, provide the purchaser a menu of subsystem options **related** to local operational criteria and vehicle cost-effectiveness. Thus, it gives

the purchaser the opportunity to make the purchased vehicle **"fit"** the airport's identifiable operational needs while avoiding **the** continuous string of time consuming protests triggered by the "proprietary" or **"exclusionary"** nature of the request for bids which favor a manufacturer.

3. It should be noted that the means to be used to fulfill all of **the** remaining automotive and fire extinguishing subsystem performance criteria not included in that menu are intended to be left to the prospective bidder.

4. THROUGH 19. RESERVED.

Section 2. Option Selection Work Sheet.

20. The guide specification provides numerous opportunities for the purchaser to make subsystem component/performance selections which effect **the** vehicle characteristics. A paragraph-by-paragraph list (menu) of those vehicle characteristics which are specifically reserved for the purchaser has been assembled in the form of a selection work sheet. A check list is provided in the right hand column of **the** work sheet on which the purchaser may indicate which of the available options are required to tailor the vehicle to the needs of his/her specific airport.

21. If a purchaser believes that additional items or modifications (including the selection of the means to fulfill the required- performance now reserved for perspective bidders) are needed to **fulfill** local, **identifiable operational requirements**, they should be added below this basic list. These additional modifications should be accompanied by a detailed, rational justification for departing from the performance orientated nature of the guide specification.

Table A4-1 Work Sheet for Subsystem Component Selection.

WORK SHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
Chapter 1. Introduction			
5.a	Seat belts; shoulder harness systems		<u>Shoulder hardness system:</u> For driver only: _____ For all pos.: _____ <u>3-points restraint seat belts:</u> _____ For driver only: _____ For all positions: _____
5.e	Provisions for mounting radios.	The specific provisions for mounting radios are a function of the type, size, shape, and operational configuration of the radio in service at the airport or being ordered as part of the vehicle purchase. Therefore, it must be tailored to the individual airport's requirements. In addition, the radio and the mounting are not a vehicle performance item.	<u>Type and location of radio:</u> _____ _____ _____ _____ _____ _____ _____ _____ _____ _____
11.k	Installation of continuous extend useful life of the vehicle.	Continuous duty cycle lubrication systems for suspension parts have shown the ability to extend the time before repair and costly maintenance is required on over-the-road as well as heavy excavation equipment. The installation of this type of system is in line with the FAA's goal of extending vehicle service life	<u>Y e s :</u> _____ <u>No:</u> _____ _____ _____ _____
13.a	Requirement to comply with painting and marking standard...AC 150/5210-5B	AC 150/5210-5B, paragraph 7. b., provides for customizing the vehicle paint scheme in terms of vehicle number, airport name, reflective striping and the airport's insignia. The original application of decorative paint schemes is expensive. The retrofitting of these paint schemes is prohibitively expensive. Therefore, detailed requirements for each of these items should be clearly defined before requesting bids on the vehicle.	<u>Numbers:</u> Side: <u>Size</u> Roof: <u>Size</u> Reflective <u>Strioing:</u> Yes - No _____ <u>Airport Name:</u> Yes- No _____ <u>Airport Logo:</u> Yes- No _____

WORK SHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
14.	Insulation, Waterproofing, Air Conditioning and Winterization	The need for AC and winterization are subject to climatic, geographical, and operational considerations which are airport specific.	<u>Air Conditioning Required:</u> Yes <u> </u> No <u> </u> <u>Winterization Required:</u> Yes <u> </u> No <u> </u> If Yes, Heated fuel/water separator required: Yes <u>N</u> <u>o</u>
Chapter 2. Automotive System			
21.	Dimensions.	In the case of overall vehicle dimensions, therefore is the potential conflict between the vehicle size in one or more of its dimension with the local operating environment. If not allowed for, this could reduce the overall cost effectiveness of the performance based specification by either restricting operational flexibility or by requiring expensive facility modifications. A justification is required for each specific dimension that is requested.	<u>Required specific dimensions:</u> <u>L e n g t h :</u> <u>H e i g h t :</u> <u>W i d t h :</u> JUSTIFICATION:
26.c.	The election of a "pintle hook" in lieu of "two towing eyes"...	Towing other vehicles with an ARFF vehicle is not a common practice. However, some operators believe that the pintle hook enhances operational flexibility. The substitution of it for the two rear towing hooks/eyes, which are intended to facilitate ARFF vehicle recovery in the case of breakdown or a stuck vehicle, does not impact the vehicle's firefighting performance, or to any great extent, its recoverability.	<u>Rear towing eyes:</u> OR <u>Pintle hook:</u>
28.a.(1)	More than two crew positions...	The need for, a seating configuration to accommodate more than two ARFF personnel per vehicle is a function of local operational practices; Therefore, it is included as an option available to the sponsor.	<u>Number of seats:</u> JUSTIFICATION
28.f	Power adjustable and heated mirrors	The power adjustable and heated mirrors might be helpful to the driver/crew member to see clearly in the bad weather.	Power adjustable and heated mirrors: Y <u>e</u> <u>s</u> : N <u>o</u> :
28.h	Roof hatch	A cab roof hatch may be requested, if manual roof turret operation from outside the cab is an operational requirement.	Roof hatch: Y <u>e</u> <u>s</u> : N <u>o</u> :

WORK SHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
29	Equipment	In addition to the function of the windshield washers and wipers a system to flush the windshield may be advantageous on vehicles with roof mounted turrets	<u>Windshield Deluge System:</u> Yes: _____ N o _____
32.a.(3) and 32.a.(4)	Means to keep brake system air reservoir up to operational pressure...	The vehicle brake air system performance requirement is specified. Which of the two and recognized methods used to keep the vehicle brake air pressure operational does not impact the "as-built" vehicle performance. However, it may impact its cost-effectiveness if the method used is not compatible with local resources. Hence, it is viewed as a local operational decision.	<u>1 10V or 220V Auxiliary On-board compressor:</u> OR <u>House air fitting:</u>
32.g	Anti-block brake system		Y e s : _____ No: _____
37	Bead locks	If tires will be operated at low pressure, bead locks may be desirable	<u>Provide bead locks:</u> Y e s : _____ N o _____
39	Optional lighting items...	These lighting items do not affect the firefighting performance of the vehicle and are not wanted by some operators. Hence, they are not required for the vehicle to be acceptable. Conversely, other operators identify various lighting items as an operational requirement. This is particularly true at airports where there is no other source for auxiliary on-site lighting. Hence, a variety of lighting items are retained as optional accessories that purchasers may request on an "as needed" basis.	<u>Identify and list items being selected:</u> Fog light(s): Yes: _____ No: _____ Spotlight(s): Yes: <u>N</u> _____ o _____: Top deck light(s) (service area): Y e s : _____ N o _____: Amber flashing beacon Yes: _____ No: _____
40.d.(1) and (2)	Mounting location for shore power plugs	The location does not affect the vehicle performance. Whereas, the local firehouse wiring configuration or personnel traffic patterns will dictate the most cost-effective or operationally advantageous location.	Identify & specify required location and specify components to be connected.
58	Off-Road High Mobility Suspension		Justification:

WORK SHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
59	DEVS	The DEVS equipment can aid normal operations, improve emergency response time, and provide an additional margin of safety for airport rescue response during periods of very low visibility operations.	Justification:
Chapter 3. Fire Extinguishing Systems			
Section 1.	Dry Chemical -- <u>Option</u> Sodium or Potassium Bicarbonate Based OR Section 2. Halotron I or an acceptable substitute -- <u>Option</u> , an acceptable substitute	The inclusion of a complimentary agent system option as part of a major ARFF vehicle is intended to facilitate the purchaser's selection of the ARFF vehicle fleet configuration that best fits the local operational situation and still complies with FAR Part 139. It should be noted that in addition to FAR Part 139 requirements, fire service managers must consider their obligations under the Montreal Protocol treaty regarding the limited (essential) use of Halotron I or approved equivalent as a fire fighting agent.	<u>Dry chemical required:</u> Yes: _____ No: _____ <u>Halotron I or approved equivalent or approved equivalent or sub required:</u> Yes <input type="checkbox"/> No <input type="checkbox"/>
72.f	Hoisting system	Aid in propellant cylinder change.	<u>Lift system required:</u> Yes, _____ No <input type="checkbox"/>
73.a.(1)	Halotron I or approved equivalent agent container	The option to select less than the normal 500 Lb container is in recognition of the airport fire service's obligations under the Montreal Protocol to select and use Halotron I or approved equivalent only where no other agent will perform the task.	<u>Identify agent:</u> _____ <u>Specify container capacity pounds:</u> _____
76.a.(1) and 76.a.(2)	Concentrate Proportioner ...range of accuracy...	For a given foam type, the fire extinguishing performance of the water/foam solutions for 6%, 3%, and 1% foam concentrates is the same. However, cost-effectiveness and/or operational compatibility with mutual aid resupply sources may dictate the need for one or the other. Proportioner performance is sensitive to both foam type and the concentration. Therefore, purchasers must identify which foam type and which foam concentrate (not the proportioner) is to be used.	<u>Agent concentrate to be used in vehicle:</u> 6 % _____ 3 % _____, OR 1 % _____

WORKSHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
78.b.	EXCEPTION : Adapters, . . .	There is a national standard for fire hose and hose connections. However, not all jurisdictions have completed the transition. Hence, to ensure that the vehicle is compatible with local fittings and that effective mutual aid arrangements can be achieved, adapters for non-standard fittings may be specified.	<u>Adapters required :</u> Yes: _____ No: _____ <u>Identify specific type.</u>
80.a.(2)	Water Reservoir and Piping...materials compatibility with local water characteristic s.	This provision is not intended to involve the purchaser in the selection of materials. It is, however, intended to minimize the lifetime costs of vehicle ownership by alerting both the manufacturer and the purchaser of the need to identify the most likely sources of water to be used in the ARFF vehicle and to ensure that the properties of that water and the materials selected by the manufacturer for tank fabrication and the related piping are compatible.	<u>Airport ARFF water supply</u> <u>has unusual characteristics :</u> Yes: _____ No: _____ <u>Identify unusual properties.</u>
81.a.	Twinned or separate water/foam and complementary agent handlines. It may be fitted with nozzles... water agent flow	The method of mounting the handline does not affect the fire extinguishing performance. However, depending on the complementary agent chosen and/or the operational tactics used at a specific airport, one method may be more cost-effective than the other. Recent USAF/FAA Large Fire Research has shown that nozzles which entrain or capture dry chemical into the agent master stream provide significant improvements in fighting three dimensional running fuel fires, a common fire scenario encountered.	<u>Separate agent Handlines :</u> OR <u>Twinned agent handlines :</u> Yes: _____ No: _____
81.b. and 81.c.	Reeled handlines... OR Woven, multiple jacket handlines...	The inclusion of both types of handlines is intended to provide the purchaser a choice that will be compatible with the airport fire department's operational requirements.	<u>Reeled; hard rubber handline:</u> OR <u>Woven jacket handlines in hose bed:</u>

WORK SHEET FOR SUBSYSTEM COMPONENT SELECTION			
AC Para. Number:	Paragraph Title or Subsystem Description:	Rational for Position:	Purchaser's Selection:
83.	Ground Sweep or Bumper Turret	This choice between agent applicators is permitted to allow for differences in operational tactics. The acceptable performance requirements for both items are specified in Table 3.	Provide ground Sweep: _____ OR Provide bumper Turret: _____
84.b.5	May be fitted with... of water agent flow.	Recent USAF/FAA Large Fire Research has shown that nozzles which entrain or capture dry chemical into the agent master stream provide significant improvements in fighting three dimensional running fuel fires, a common fire scenario encountered	Yes: _____ No: _____
84.b.6	Roof mounted turrets (Optional flow) may have flow rates reduced up to 30% proportionall Y	Recent USAF/FAA sponsored Large Fire research has shown significant fire knock down improvements with ground level or low ground positioning, (close to the fuel surface and parallel to ground agent applications) of AFFF. In large pool fire tests increased efficiency resulted with extremely rapid pool fire control or knockdown. The election of larger bumper turret application rates could improve agent application techniques of standard rescue vehicles without installing elevated devices with ground proximity application capabilities.	Y e _ s _ : No: _____
8 6 .	Undertruck Nozzles -- Option . .to have or not...	The cost-effectiveness of this specific agent applicator on ARFF vehicles has been seriously questioned by many in the firefighting service, both nationally and internationally. Its absence is not likely to adversely impact the overall aircraft fire fighting performance of an ARFF vehicle. It is known to add to the overall maintenance costs for the owner. Before selecting this option, the purchaser should carefully evaluate its potential value.	Provide under-truck nozzles: Y _ e _ No:s _ _ _ _ :

OTHER DEVIATIONS FROM THE GUIDANCE CONTAINED IN AC 15015220-I OA. 7/3/91 SHOULD BE LISTED BELOW BY PARAGRAPH NUMBER AND TOPIC AND THE RATIONAL FOR THE REQUESTED DEVIATION PROVIDED.

THEORY OF THE EARTH

The theory of the earth is a branch of geology which deals with the origin and development of the earth and its various parts. It is a science which seeks to explain the processes which have shaped the earth and its features. The theory of the earth is based on the study of the earth's structure and its history. It is a science which seeks to explain the processes which have shaped the earth and its features. The theory of the earth is based on the study of the earth's structure and its history. It is a science which seeks to explain the processes which have shaped the earth and its features.

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